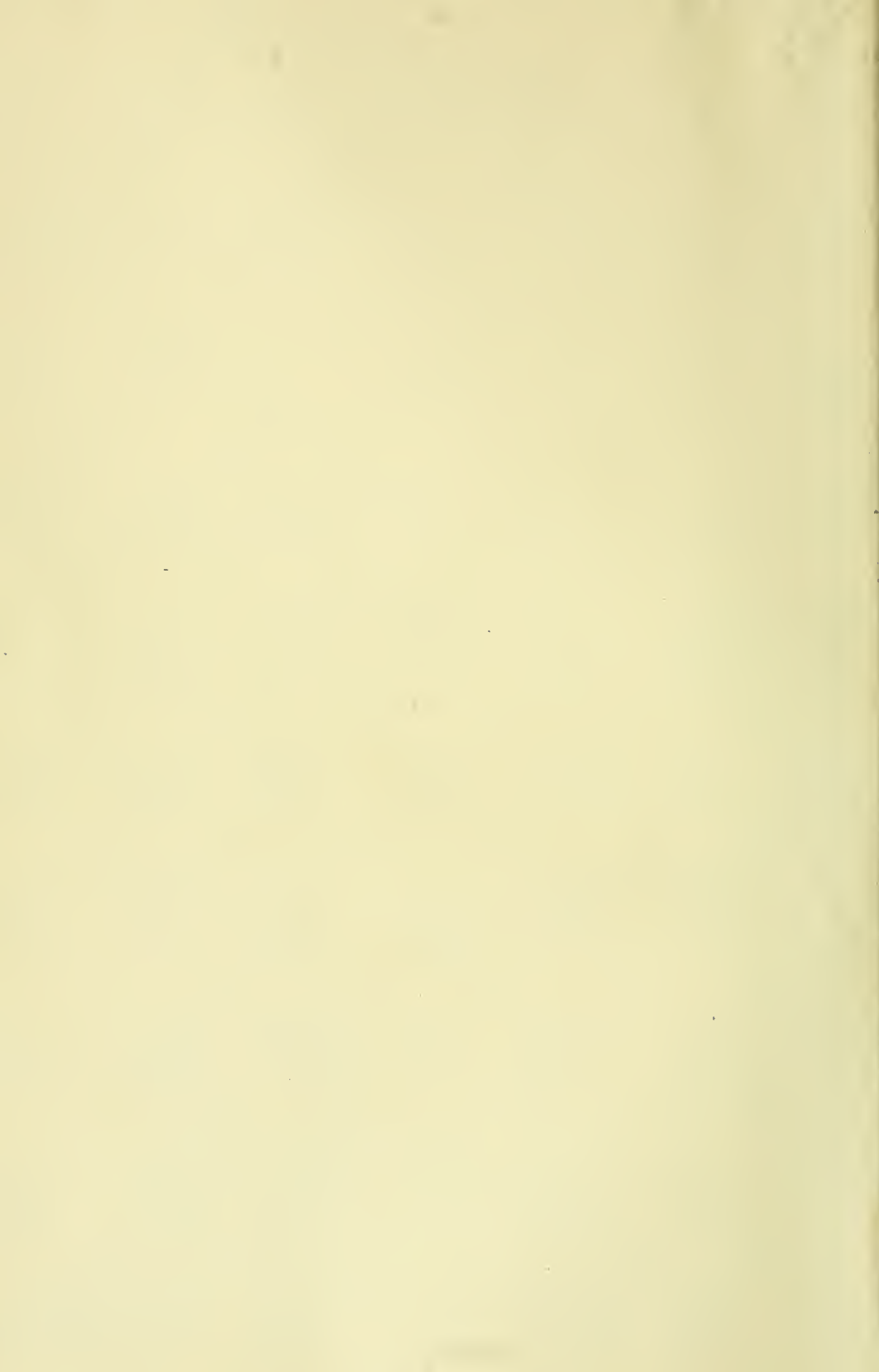# HIGH · SCHOOL
QUESTION · BOOK.

THE

HIGH SCHOOL QUESTION BOOK;

QUESTIONS AND ANSWERS

EMBRACING ADVANCED ENGLISH STUDIES USUALLY
PURSUED IN PUBLIC HIGH SCHOOLS,
ACADEMIES, ETC.

INTERSPERSED WITH

APPROPRIATE EXPLANATORY NOTES
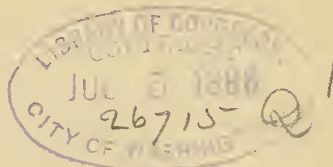### ELUCIDATING AND ENLARGING THE CONTEXT,

DESIGNED TO AID THE STUDENT IN HIS EFFORTS FOR SELF-
EDUCATION; ALSO, TO PREPARE THE COMMON
SCHOOL TEACHER FOR A STEP
HIGHER IN HIS CHOSEN
PROFESSION.

WITH AN APPENDIX.

EDITED BY
W. H. F. HENRY,
AUTHOR OF THE "NORMAL HISTORY OF THE UNITED STATES," "THE
VOICE OF THE PEOPLE," "MANUAL OF PARLIAMENTARY
LAW," "GOVERNMENTS OF THE WORLD," ETC.

PREFACE.

To do justice to a work of this character, and at the same time not to make it voluminous, has been no light task.

In its preparation it has been our endeavor to make the Questions concise and unambiguous, and the corresponding Answers satisfying and comprehensive. Great care has been exercised to render these Answers consistent and applicable, and to compile them from the best authorities.

Throughout the work are interspersed (in smaller type) appropriate explanatory notes and comments elucidating the context. They supply also much additional information, which could not be included in the direct Answer without undue elaboration.

The plan and scope of the work is Normal, and only the most useful and practical points are touched in the direct answers, while in the notes these answers are somewhat elaborated. The work has required much patient research and labor of condensation and elimination from various authentic sources.

Feb., 1886.   W. H. F. Henry.

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THE

HIGH SCHOOL QUESTION BOOK.

SECTION I.

GENERAL HISTORY.

INTRODUCTION.

1. *What is History?*

History is any record of events. It describes the past conditions and actions of men, investigates the causes which have operated to produce them, and traces the effects or results of events.

The facts of history comprise the sum of events that man has brought about in all the teeming centuries since first he inhabited the earth. The number is beyond the power of imagination to conceive, and historians do not attempt to enumerate them. They describe some of the grandest and most interesting features of a nation's life, and leave the rest to be inferred or forgotten.

2. *How should history be properly taught?*

From a series of progressive standpoints.

In the history of every nation there are certain prominent events from which, as centers, other minor events have seemed to emanate, and to which they bear reference. It is only of these great events that we need know the dates or the minute particulars.

3. *How much history should be expected of pupils in our common schools?*

A knowledge of the history of their own country; but in the higher schools it should be extended to universal history.

(7)

No one can do without a familiarity with the history of his own country. To every American citizen this knowledge is useful; he should know of the founding, progress, and growth of liberty in his own country. Towards the preservation of good government and the permanency of our institutions, it is necessary that the principles of government and the leading events of history be taught in our American schools. "The idea of national unity and patriotism should rise above the strifes of party and the turmoil of war, and plant itself as the one thing vital to American institutions."

The study of history furnishes a valuable intellectual discipline; and the many examples of good and great men and women who honored by their noble deeds the age and country in which they lived, exert a healthful moral influence. Moral examples have more influence upon the young than moral precepts.

4. *What forms may the records of history take?*

Of *History* proper, which is the record of the life of a nation, or people; of *Biography,* which is a record of the life of an individual; of *Annals,* in which events are arranged in chronological order under consecutive years; of *Chronicles,* in which events are narrated simply in the order of their occurrence; or of *Memoirs,* which are composed from personal experience.

5. *What is Political History?*

Political history is a mere record of wars, conquests, massacres, plots, and the doings of kings and rulers.

6. *What is Philosophy of History?*

Philosophy of history is an examination into *causes* and *effects* of events.

It should receive careful attention from the student of history, as only a clear understanding of the causes which lead to wars and revolutions can make intelligible the events themselves. The origin, character, and surroundings of a people must be well understood before we can correctly estimate the part which that people play in the history of the world.

7. *What are the chief elements in the character of a people?*

Race, geographical location, religion, system of government, educational facilities, and natural resources of the country.

8. *What are the sources of history?*

The chief sources of history are:

(1) **Authentic records,** of which the *Bible* is the most ancient.

(2) **Oral tradition,** which existed before the invention of the art of writing.

From this source Herodotus, one of the earliest profane historians, derived the greater part of the facts which he relates.

(3) **Historical poems,** such as the *Iliad* and *Odyssey* of Homer, which comprised the only history of the heroic age of Greece.

(4) **Monuments and ruins,** as the Pyramids of Egypt, and the remains of such ancient cities as Balbec, Babylon, Troy, Nineveh, Palmyra, and Persepolis, which serve to give an idea of the taste, power, and opulence of those by whom they were built.

(5) **Coins and medals** have always been of great utility in illustrating history, and of giving some insight into the manners and customs of those nations to which they belonged.

(6) **Inscriptions on marbles,** the most celebrated collections of which are those at the University of Oxford, England, called the Arundelian Marbles, from the Earl of Arundel, by whom they were brought from Greece.

Of these inscriptions, the most important is the *Chronicle of Paros*, which contains the chronology of Athens from the time of Cecrops, B. C. 1582 to B. C. 264.

9. *What sciences are necessary to a proper understanding of history?*

ETHNOLOGY, or the science of the several races, or types of mankind.

ARCHÆOLOGY, or the science of the ancient works of man.

GEOLOGY, or the science which treats of the formation and development of the earth.

PHILOLOGY, or the science of language.

PHYSICAL GEOGRAPHY, which treats of the earth with reference to the conformation and structure of its surface, its climate, and its natural resources.

10. *What can be said of the antiquity of man?*

The antiquity of man is much greater than is indicated by any kind of written records whatever.

This is distinctly proven by Archæology, Geology, and Philology. Human bones, implements of war, domestic utensils, etc., have been found in such situations as to show clearly that they were placed there long before the dawn of authentic history, which scarcely dates back to 3,000 years before Christ.

11. *What are the recognized races or types of mankind?*

Mankind is divided into five well recognized races, differing in intellect, features, color, stature, etc. These strongly marked di-

visions are the CAUCASIAN, MONGOLIAN, MALAY, NEGRO, and AMERICAN.

The Caucasian is the great historical and progressive race. Its history is the history of civilization.

12. *How is this historical stock—the Caucasian race—divided?*

Modern scholars divide it into three main branches: The ARYAN, or INDO-EUROPEAN branch; the SEMITIC branch; the HAMITIC branch.

This classification is a *linguistic* one—that is to say, it is a division based on the nature of the languages spoken by the three families of nations—but at the same time it represents three distinct civilizations.

13. *What is the Aryan branch?*

It is that division to which we ourselves belong: it includes nearly all the present and past nations of Europe,—the Greeks, Latins, Germans (Teutons), Celts, and Slavonians,—with two ancient Asiatic peoples, namely, the Hindoos and the Persians.

The word *Aryan* means *noble, excellent*, and in their influence on civilization, the Aryans predominate. The primitive Aryans lived in the regions east of the Caspian Sea.

14. *What does the Semitic branch include?*

The ancient inhabitants of Syria, Arabia, and the Tigris and Euphrates countries. The leading historical representatives of the Semitic branch are the Hebrews, Phœnicians, Assyrians, and Arabs.

15. *What people represent the Hamitic branch?*

It has but one prominent representative,—the Egyptians. It is probable, however, that the ancient Chaldæans also belonged to this race.

16. *How is history divided?*

With respect to time, history is divided into *Ancient, Medieval,* and *Modern.*

17. *What is Ancient History?*

Ancient history embraces the history of the world from the earliest period to the fall of the Western Roman Empire, 476 A. D.

18. *What is Medieval History?*

Medieval history, or the "Middle Ages", comprises the history of the world from the fall of the Western Roman Empire (A. D. 476) to the close of the 15th century, or to the fall of Constantinople, A. D. 1453.

Some historians, however, place the interval of the Middle Ages from the fall of the Western Roman Empire to the discovery of America, 1492.

19. *What is Modern History?*

Modern history comprises the history of the world from the close of the 15th century to the present time.

There is, however, a difference of opinion with regard to the line which separates ancient from modern history. Some historians adopt the Christian era for the commencement of modern history; others take the downfall of Rome; while others again carry it down as far as the establishment of the New Empire of the West, under Charlemagne, A. D. 800.

20. *What events distinguish ancient history?*

The creation of man; the Deluge; the dispersion of mankind; and the formation of the four great Empires of Assyria, Persia, Greece, and Rome, which in time arose, flourished, and decayed.

21. *What events distinguish medieval history?*

The spread of Christianity; the fall of the Roman Empire; the rise of the principal modern nations of Europe; the rise, progress, and decline of Mohammedanism; the establishment of the Feudal System; the Crusades; Chivalry; the invention of gunpowder and the art of printing.

22. *What events distinguish modern history?*

The discovery of America; the revival of letters; the Reformation; the rise of the United States of America; the invention of the steam-engine, the magnetic telegraph, the sewing-machine; and many advances and improvements in the arts, sciences, and social condition of man.

ANCIENT HISTORY.

23. *What comprised the ancient Oriental monarchies?*

Egypt, Assyria and Babylonia, Judea, Phœnicia, India, and Persia.

With the single exception of Egypt, the seat of all the ancient Oriental nations was in Asia. *Historical* Asia is in reality *Southwestern* Asia.

24. *Where arose the earliest nations recorded in history?*

In the three alluvial plains of the Nile, of the Tigris and Euphrates, and of the Indus.

This fact was wholly due to physical causes. In a primitive state of society population can gather into nations only in regions where a fertile soil produces abundant food. Here nature spontaneously produces certain important articles of food, such as dates, rice, etc., which, being easily cultivated and yielding immense returns, made a large population possible.

25. *What was the "cradle of nations"?*

The alluvial plains of Southwest Asia (taking in Egypt).

26. *When does history, proper, commence?*

History commences when historical records commence.

We must leave to revelation and to science the consideration of primitive humanity, and take up our studies with those ancient Oriental nations that appear on the stage of human affairs when historic records begin.

27. *What may be said of the antiquity of Egypt?*

Egypt itself may not have been the oldest *nation*, but Egyptian history is certainly the oldest *history*.

Egypt is the country in which we first find a government and political institutions established. Its monuments, records, and literature surpass in antiquity those of Chaldea and India, the two next oldest nations.

28. *Name the three divisions of ancient Egypt.*

Lower Egypt, or the Delta; Middle Egypt, or the Heptanomis; Upper Egypt, or the Thebais.

29. *Why has Egypt been called "the Gift of the Nile"?*

In its annual overflow (due to the immense rainfalls in the Abyssinian mountains), the Nile, by its mud deposits, renews every year the soil of Egypt, so that all the people had to do was to plant, and nature produced.

30. *What were the old sources of information regarding Egypt?*

These were derived chiefly from the narratives of the Greek historians, and especially from that of Herodotus, called the father of history, and from some fragments of a history written in Greek by Manetho, an Egyptian priest, in the 3d century B. C.

31. What are the new sources of information?

The art of reading the *hieroglyphics,* a term meaning sacred carvings, or priestly writing.

The knowledge of the reading of these died out with the decline of Egypt, and "hieroglyphics" became a synonym for everything that is mysterious.

32. What was the " Rosetta stone"?

During the expedition of the French to Egypt, under Napoleon, at the close of the last century, an engineer, in digging the foundation of a fort near the Rosetta mouth of the Nile, found a stone tablet, about three feet long, on which was an inscription in three different characters. This was the famous "Rosetta stone." One of the three texts (the lower one) was Greek, and of course was readily translated; the text at the head was in the mystic hieroglyphic character; the intermediate text was in a character since called *demotic* (*demos,* the people), that is, the writing of the common people. This inscription was copied and circulated among scholars, and after long and ingenious efforts the alphabet of the hieroglyphics was made out; so that now these carvings are read with ease and certainty, and a new flood of light has been thrown on the history of ancient Egypt. The great work of deciphering these characters was mainly effected by the French savant, Champollion.

33. What was the grand age of Egyptian history?

The most splendid period of Egyptian history was from the eighteenth to the twentieth dynasties,—about three centuries (1525—1200 B. C.).

At the head of the eighteenth dynasty is supposed to have been that Pharaoh "who know not Joseph." The exodus of the Israelites from Egypt is believed to have taken place 1320 B. C., during the reign of Meneptha, the fourth king of the nineteenth dynasty—the Pharaoh whose heart was hardened, and who was drowned in the Red Sea.

34. When was the age of Egyptian decay?

From the twentieth dynasty onward Egypt declined for six centuries, till finally it was conquered by the Persians under Cambyses, 525 B. C. In 332 Egypt fell under the dominion of Alexander the Great, who founded on its shore the new capital and literary and commercial center called Alexandria. One of his generals, named Ptolemy, received Egypt as his fragment of the

divided empire of Alexander, 323 B. C. Thenceforward for three centuries the Greek dynasty of the Ptolemies ruled on the banks of the Nile till Queen Cleopatra, the last of the line, being overcome by the Romans, died by her own hand; and the venerable land became a Roman province.

35. *What was the government of ancient Egypt?*

A hereditary monarchy, the kings being called *Pharaohs.*

The public duties and daily habits of the king were prescribed by religious rule; so that the priestly class formed the " power behind the throne." In another respect an Egyptian king differed from an Eastern despot: his power over the lives and property of his subjects was strictly limited by law, and nothing left to caprice and passion.

36. *What was the system of Caste?*

By the system of *caste*, each individual, instead of being able to make his own place and fortune in the world, had his lot marked out by his birth: he had to be what his father was. Of these castes, or ranks, there were three broad divisions,—the priests, the soldiers, and the lower orders.

The priests were the richest, most powerful, and most influential order. Their ascendency over the minds of the people was immense. The military caste was the next in importance. The lower castes embraced the husbandmen, the artificers, and the herdsmen.

37. *What was the effect of the caste system?*

It was one of the main causes of the decline of the nation. It discouraged progress and improvement; it crushed out personal ambition; it produced dull uniformity.

38. *What were the two most famous cities of ancient Egypt?*

Memphis and Thebes. Memphis was about twelve miles above the apex of the Delta. Thebes was the metropolis of Upper Egypt, and the most splendid city of the Nile.

Scarcely a vestige of Memphis now remains; but its great burial place at Gizeh is still seen. Here are the great Pyramids, the colossal Sphinx, and miles on miles of rock-hewn tombs. The traveler who now views the ruins of Thebes at Karnak and Luxor beholds pillared temples and statues of a size so colossal as to seem like the works of giant hands.

39. *What distinguishes Egyptian architecture?*

The distinguishing feature of Egyptian architecture is its vastness and sublimity. Avenues of colossal sphinxes and lines of obelisks led to stupendous palaces and temples, elaborately sculp-

tured, and containing halls of solemn and gloomy grandeur, in which our largest cathedrals might stand.

40. *What were the pyramids?*

They were huge structures of stone designed as the sepulchers of kings.

As many as seventy stand on the left bank of the Nile, just beyond the cultivated ground, in the vicinity of Memphis.

41. *Which are the most celebrated of the pyramids?*

The three great pyramids of Gizeh. The largest is 450 feet high; it has a square base of 764 feet, and it covers an area of more than thirteen acres,—twice the extent of any other building in the world. The second pyramid is but little less; the third is about half the size.

In the construction of these works no degree of labor for any length of time seems to have intimidated the Egyptians. The huge blocks of stone, sometimes weighing 1600 tons each, were dragged for hundreds of miles on sledges.

42. *What of writing material among the Egyptians?*

It was their custom to mark every object and article of use or ornament. For manuscript an excellent writing material was made from the leaves of the *pa-py'-rus*,—whence our word "paper."

43. *What was a striking peculiarity of the Egyptian religion?*

The honor paid to brutes. The dog, the cat, the ibis, and the hawk were held in reverence throughout the whole land,—other animals were worshiped only in special *nomes*, or districts.

The highest honors were paid to the bull Apis at Memphis, and to the calf Mne'-vis at Heliop'-olis. The sacred animals were kept in the temples, ministered to with the greatest care, and when they died they were embalmed. If a person killed an ibis or a hawk, whether intentionally or not, he was immediately put to death.

44. *Why did the Egyptians embalm dead bodies?*

The original reason was the belief that at the day of judgment the soul would reunite with the body; hence the care taken to preserve the corpse from corruption, and hence also the great pains taken to ornament the interior of their stone-hewn sepulchers, since, even while lying in the tomb, the body was believed to be not wholly unconscious.

45. *What may be said of Egyptian arts and manufactures?*

In the polishing and engraving of precious stones, in glass manufacture, porcelain-making, and in embalming and dyeing, they had attained great skill. They raised flax, out of which they made fine linen; they worked in metals from the earliest recorded period; their walls and ceilings they painted in beautiful patterns, which we still imitate.

46. *What was the great characteristic of Egyptian institutions?*

Their unchangeableness. This stationary character is seen in their government, society, religion, art, and learning. Egypt herself was a *mummy*.

47. *What may be said of the antiquity of the Assyrians and Babylonians?*

In Mesopotamia ("the land of Shinar") the Scriptures place the building of Babel, the first great city founded after the Deluge, and *there* occurred the confusion of tongues and the dispersion of races.

48. *What were the three nations of the Tigro-Euphrates basin?*

The early Babylonian, or Chaldæan, Kingdom; the Assyrian Empire; the later Babylonian Kingdom.

49. *Who was the founder of these kingdoms?*

The Hebrew records name Nimrod; and the book of Genesis also reveals to us the existence of four cities, that ruled over the Empire established by Nimrod,—all of which have been identified in modern times.

50. *What was the early history of Assyria?*

The Assyrians originally lived in Chaldæa, but at an early period removed to the upper course of the Tigris. For six centuries it was the great imperial power of Western Asia.

Among the famous monarchs of the first period were Tiglath-pilser I., a conquering prince, and Asshuridanni (the original of Sardanapalus, but wholly unlike that mythic king), to whose time belong the winged bulls and lions and the sculptured palace-walls which have been dug from the ruins of Calah. The "era of Nabonassar" was 747 B. C. The second period was that of Sennacherib, who made extensive conquests, and was the builder of magnificent structures at Nineveh. This was the golden age of Assyrian art.

51. *What was the extent of the Assyrian Empire?*

The countries included within the limits of Assyria, at the height of its glory, were Babylonia (covering all the territory of the early Chaldæan kingdom), Mesopotamia, Media, Syria, Phœnicia, a large part of Palestine, Arabia, and Egypt. The Assyrian monarch as the "king of kings," compelled the kings of subject states to do homage and to pay tribute.

52. *What caused the decay of the Assyrian Empire?*

Owing to a constant succession of revolts, wars, subjugations, and deportations of whole populations, Assyria had no inherent strength. After the 7th century B. C. it began rapidly to fall in pieces.

In the 7th century Babylon made a successful rebellion; and when the Median conqueror Cyaxares led a force against Assyria, he was joined by the Babylonians under Nabopolassar, the Assyrians were overthrown, Nineveh was captured, its splendid palaces and temples were given to the flames, and Assyria fell, never to rise again (625 B. C.).

53. *What may be said of Assyrian civilization?*

Their genius took mainly the form of art and manufactures. In letters and in science they were behind both the Chaldæans and the Egyptians. Architecture was their chief glory. Their sculpture, too, though never attaining Grecian purity and perfection, was far in advance of Egyptian stiffness and conventionalism.

In the useful and mechanical arts they had reached great skill. They had transparent glass; constructed tunnels, aqueducts, and drains; they used the pulley, the lever, and the roller; they understood the arts of inlaying, enameling, and overlaying with metals; and in the ordinary arts of life they were, twenty-five centuries ago, nearly on a par with the boasted achievements of the moderns.

54. *What was the political situation of the later Babylonian kingdom?*

When Assyria was overthrown by the Medes (625 B. C.), Nabopolassar, who had aided the Medes, received as his share of the spoil the undisputed possession of Babylonia.

This later Babylonian Kingdom lasted for eighty-seven years (625-538 B. C.) till overthrown by the new conquering power of Persia.

55. *Who was Nebuchadnezzar?*

He was the son of Nabopolassar, the first monarch of the new

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Babylonian kingdom. Under him the empire reached its height of glory.

During his long reign of forty-three years Nebuchadnezzar undertook many wars, in which the siege of Tyre and the siege of Jerusalem stand out as conspicuous achievements. Besides his conquests, he almost entirely rebuilt the city of Babylon.

56. *Give a brief description of ancient Babylon.*

Babylon was a square city at least five times as large as London, and traversed diagonally by the Euphrates. Its walls—338 feet high and 85 feet thick—were studded with towers and pierced with brazen gates. Its palaces and its hanging gardens—a system of terraces in imitation of mountain scenery, formed to please Nebuchadnezzar's Median queen—were among the wonders of the world.

57. *Describe, in brief, the Persian conquest of Babylon.*

Under the command of the great Cyrus the Persians had gained ascendency over the Medes and begun a career of conquest. Appearing in Mesopotamia, they laid siege to Babylon, which was entered by diverting the course of the Euphrates, 538 B. C.

Herodotus states that Babylon was taken "amid revelries,"—thus confirming the account given in the Scriptures of the circumstances of the capture. The fearful handwriting on the palace wall, and the terrible denunciation of the prophet, form a scene too deeply impressed on our memories to need repetition here.

58. *What was the later history of Assyria and Babylonia?*

Conquered by the Persians in the 6th century, Assyria and Babylonia became a part of the vast possessions of Alexander the Great. It is now a vast heap of ruins, tenanted only by the beasts and birds that love to haunt solitary places.

59. *Who were the Hebrews?*

They were a pure Semitic race, and hence were kinsmen of the Phœnicians, Arabs, and Assyrians.

60. *What was the beginning of Jewish history?*

Jewish natural history begins at the time of the departure of the children of Israel from Egypt, about 1320 B. C.

The history of Abraham, and of his sons and grandsons, is simply the story of a nomad family.

61. *What was the first period of Jewish history?*

During the first period the Hebrew government was a theocracy (or a government of God), the divine will being manifested through the high-priest. There was a succession of rulers and "Judges," guided by revelation. The last of these rulers was the prophet Samuel.

62. *What does the second period of Jewish history include?*

It includes the era of the united monarchy, and it continues through three reigns.

The first of the kings was Saul, who was succeeded by his son-in-law David. David was the greatest that ever ruled the nation. His son Solomon succeeded him. During Solomon's reign the Jewish state was a real imperial power.

63. *What was the period of Jewish decline?*

The third period, which set in immediately after the reign of Solomon.

The subject states threw off the Jewish yoke; disunion took place among the Jews themselves, and the imperial power crumbled into two petty kingdoms,—that of Israel (capital at Samaria) composed of ten out of the twelve tribes, and that of Judah (capital at Jerusalem) made up of the other two.

64. *What was the duration and the fate of the kingdom of Israel?*

It lasted for about 250 years. The ten tribes were overwhelmed by the king of Assyria, and carried into captivity, 721 B. C. The triumph of Cyrus over Babylonia was followed by an edict by which the Jews were restored to their homes (536 B. C.).

65. *Give a summary of Jewish history as a whole.*

(1) The Jewish state was but a limited domain—being only 150 miles long by about fifty miles wide; (2) Compared with the great Oriental empires, with Assyria and Babylonia, Egypt, and Persia, its political importance was slight; (3) The Jewish people contributed little to ancient civilization, so far as regards art, science, or politics.

66. *What may be said of the Phœnicians?*

They were the earliest commercial and colonizing people on the shores of the Mediterranean. They founded the famous city of Carthage, and had made settlements as far west as the Strait of

Gibraltar ("Pillars of Hercules"). They were navigators, merchants, and planters of colonies several centuries before the Greeks rose to any note in the world.

They were the inventors of the first perfect *alphabet*. The period of this invention is not definitely known. The art of alphabetic writing is probably the most important invention ever made by man. The Greeks got the alphabet from the Phœnicians, and the Romans got it from the Greeks, with some changes. The Roman alphabet is the basis of our modern alphabet.

67. *How did the Greeks obtain the alphabet from the Phœnicians?*

The account is that "Cadmus brought sixteen letters from Phœnicia into Greece, to which Palamedes, in the time of the Trojan war, added four more, and Simonides afterward added four."

Modern scholars, however, have proved that *Cadmus* is a mere fabled name signifying "the East."

68. *Of what did Phœnicia consist?*

Of several independent states, each city being a separate state, under its own king.

69. *What were its chief cities?*

Sidon and Tyre. Sidon was the most ancient; and Tyre became the most flourishing of all the Phœnician community.

70. *Where were the primitive Hindoos located?*

They first settled in the northwestern part of India, which was then occupied by native dark races, who were soon subdued by the Hindoos.

By intermixing with the native tribes, the Hindoos lost much of their purity of blood. This explains much that is peculiar in the civilization of the Hindoos.

71. *What was the caste system among the Hindoos?*

The Hindoos made four divisions of society: 1. The BRAHMINS, whose proper business was religion and philosophy; 2. The KOHATRIYAS, who attended to war and government; 3. The VAISYAS, who were the merchants and farmers; 4. The SUDRAS, or artisans and laborers. Below even the lowest of these classes were the *Pariahs,* or outcasts, who performed the meanest of all labors.

72. *What was the language of the ancient Hindoos?*

The Sanscrit; it is not now spoken, and is understood only by the Brahmins and by scholars who have studied it.

73. *What was the religion of the Hindoos?*

The sacred writings of the Hindoos are in the *Vedas*, which sets forth the doctrine that there is " one unknown true Being, all-present, all-powerful, the creator, preserver, and destroyer of the universe." The prevailing theology is *pantheism*, or that system which speaks of God as the soul of the universe, or as the universe itself.

The Invisible Supreme Being, according to the Hindoos, manifests himself in three forms,—as Brahma the creator, Vishnu the preserver, and Siva the destroyer.

The central point of the Hindoo theology was the doctrine of the transmigration of souls. According to this doctrine the human soul is joined to earthly bodies only for the purpose of punishment, and its aim and effort are to reunite itself with the Divine Spirit of the universe.

74. *What remains of ancient art in India?*

Among the most remarkable of the monuments are the rock-hewn temples and grottoes, especially those found in the middle of Lower India, and on the Island of Elephanta, in the Bay of Bombay.

These are elaborately sculptured and inscribed, and must have required the labor of thousands of hands for ages.

75. *What new system of religion arose in India in the 6th century B. C.?*

Buddhism, founded by an Indian prince named Gautama. It grew out of a social and religious reaction from the abuses of the old Brahminism. It spread rapidly, and is still the religion of one-third of the human race.

76. *What was the origin of the Medes and Persians?*

They were both pure Aryans. By various successive movements, they established themselves in the highlands of Media and Persia.

77. *What is the " Legend of Cyrus"?*

Astyages, having dreamed that his daughter's son should conquer all Asia, intrusted to a courtier the task of killing the little Cyrus. The courtier gave the child to a herdsman, who promised

to expose it on the mountains. But the herdsman substituted his own dead baby for the living prince, who grew up in a humble station. The secret was disclosed when Cyrus began to lord it over his playfellows and beat them. Whether this legend be true or false, under Cyrus the Persians became the ruling power.

78. *What were the conquests of Cyrus?*

He first subdued all the northern and western provinces of the old Median kingdom. The most formidable enemy he encountered was Crœsus, King of Lydia, in Asia Minor, but Crœsus was overthrown. Next, most of the Greek cities and colonies on the coast of Asia Minor and the adjoining islands were subdued. He subdued various tribes in the region between Persia and the Indus. He reduced also the mighty power of Babylon (538 B. C.).

79. *What was the character of Cyrus?*

Of the whole line of Persian monarchs Cyrus was the greatest, and his character is far more worthy of respect than that of any of his successors. He was a great conqueror without being a cruel ruler, and to remarkable ability as a soldier he added many noble traits as a man.

80. *Who was Cambyses?*

He was the son and successor of Cyrus.

81. *What was the chief event of Cambyses's reign?*

His conquest of Egypt in 525 B. C. He was wanton and cruel. He forced the Egyptian king to drink poison; he shocked the Egyptians by stabbing a calf which they regarded as sacred; and on one occasion, when a courtier told him at his own request that popular rumor blamed him for drinking to excess, he pierced the heart of the courtier's son with an arrow.

82. *What may be said of Darius?*

He was, next to Cyrus, the greatest of the Persian monarchs. Cyrus by his conquests *founded* the empire; Darius *organized* it.

Darius divided the whole empire into twenty "satrapires," or provinces. A fixed rate of tribute took the place of arbitrary exactions. "Royal roads" were established, and a system of posts arranged, whereby the court received rapid intelligence of all that occurred in the provinces.

83. *What was the Persian character?*

Though not highly intellectual, the Persians were keen-witted, vivacious and fond of poetry and art. They afterwards lost their noblest traits of character and became a servile Asiatic race.

84. *What was the religion of the ancient Persians?*

The doctrine of the perpetual conflict of two great First Principles, that of *Light* and that of *Darkness*, personified under the names of Auramazda (or Ormazd), and Ahriman.

The Persian religion was further corrupted by the intermixture of a system of *fire worship*. The priests of this rite were the Magi. On lofty mountain-spots fire altars were erected, on which burned a perpetual flame. Here the Magi practiced those arts called, after them, *magic*.

85. *What was the nature of ancient Persian government?*

The government was upon the whole singularly mild, and by far the noblest and the best of all the universal empires of antiquity.

86. *Mention some of the literature of the ancient Persians.*

The *Zend Avesta*, containing the sacred books of the Persians, compiled by ZOROASTER, the great religious legislator of the Persians; and the *Shah Nameh*, an epic poem based on ancient traditions.

87. *What were the most commercial nations of antiquity anterior to the Greek?*

The Babylonians, Phœnicians, and Carthaginians.

88. *Who were the leading commercial people of ancient Asia?*

The Phœnicians. Caravans brought through the desert myrrh, frankincense, cassia, gold and precious stones.

The Mediterranean Sea was, however, the great highway of Phœnician commerce. They pushed their trade into Spain, the richest country of the ancient world. From Spain they proceeded to the south of the British Isles, where they procured the tin of Cornwall. They had also trading establishments on the Arabian and Persian Gulfs, whence they traded with the coasts of India and Africa and the Island of Ceylon.

89. *What was the commerce of Carthage?*

The principal land trade of the Carthaginians was by caravans with the barbarous tribes of Central Africa, the chief imports

being negro slaves and gold dust. In the Mediterranean their chief trade was with the Greek colonies, and with Spain, the El Dorado of antiquity.

90. *What is a marked contrast between Oriental and European history?*

The history of the Orient is the history of *dynasties*, or despotisms; the history of Greece and Rome is the history of the *people;* the latter, therefore, is far more interesting, more instructive, and more valuable.

91. *Of what stock were the Greeks a branch?*

Of the mighty Aryan, or Indo-European, stock,—the stock that includes all the historic races of Europe, together with the Persians and Hindoos of Asia.

As Aryans, they were closely related to the Romans; and, in fact, the forefathers of the Greeks and of the Italians formed originally one swarm, which at a very early period in prehistoric times left the native hive of the Aryans, in Asia, and moved into Europe.

92. *What did Northern Greece contain?*

Two principal countries, Thessaly and Epirus. To the north of these was Macedonia, which, though ruled by kings of Héllenic blood, was never counted to be part of Greece till quite late times.

93. *What did Central Greece contain?*

Eleven states; the most important of which was Attica. In Attica was Athens, the foremost city of all Greece.

94. *What did Southern Greece contain?*

Southern Greece, or the Peloponnesus, contained seven principal states; the most important of which was Laconia,-sometimes called Lacedæmon, of which the capital and most important city was Sparta.

The isles of Greéce formed a very considerable and noted part of ancient Greece. The most important islands were Eubæa, Corcyra, and Crete.

95. *What of the " legendary age" of the Greeks?*

The Greeks of this age have no history. The place of this they supplied by a mass of beautiful legends, called by themselves *myths.* This period is called the *Heroïc Age.*

96. *What was the last and greatest enterprise of the Heroic age?*

The siege of Troy. This was immortalized by the genius of Homer in his *Iliad* (from *Ilium*, or Troy).

The outline of the story is as follows: Paris, son of Priam, King of Troy, abused the hospitality of Menelaus, King of Sparta, by carrying off his wife Helen, the most beautiful woman of the age. At the call of Menelaus all the Grecian princes assembled in arms, elected his brother Agamemnon leader of the expedition, and sailed across the Ægæan to recover the faithless fair one. Nearly all Asia Minor was leagued with Troy, and the most valiant Trojan leader was Hector, son of Priam. It was not till the tenth year that Troy yielded, and it is with the events of this year that the Iliad deals.

Achilles, the bravest and most redoubtable of the Greeks, offended by Agamemnon, abstains from the war; and in his absence, the Greeks are no match for Hector. The Trojans drive them back into their camp, and are already setting fire to their ships when Achilles gives his armor to his friend Patroclus, and allows him to charge at the head of the Myrmidons. Patroclus repulses the Trojans from the ships, but the god Apollo is against him, and he falls under the spear of Hector. This causes Achilles to return into the Grecian camp, and he slays Hector in single combat; but is himself killed by an arrow directed by Apollo. Finally, the noblest combatants on both sides have fallen, the city is taken by the Greeks, through the stratagem of a wooden horse, devised by the crafty Ulysses. Troy is delivered over to the sword, and its glory sinks in ashes.

97. *What were the three periods of Greek History?*

(1) From the Dorian migration to the beginning of the Persian Wars (1100–500 B. C.). (2) From the beginning of the Persian Wars to the subjugation of Greece by Philip of Macedon (500–338 B. C.). (3) From the subjugation of Greece by Philip to the Roman conquest (338–146 B. C.).

98. *What was the chief cause of the rapid progress of Greece?*

The establishment of many colonies in countries pre-eminently favored by nature in productions and climate, and so situated as to prompt the inhabitants to navigation and commerce.

99. *What were the two leading races of Greece?*

The Ionians and the Dorians.

The Ionians were remarkable for their democratic spirit. The Dorians were noted for their aristocratic tendencies, and maintenance of slavery. This striking difference was the principal cause of the deep-rooted antagonism between Athens, the representative of the Ionian race, and Sparta, the leading Doric state.

100. *When does the authentic history of Greece commence?*

With the epoch known as the First Olympiad, B. C. 776; the Second Olympiad began in midsummer of 772 B. C., etc.,—the Olympiads recurring every four years.

In Greece the Olympic games, celebrated every fourth 'year, were fixed upon as a basis for an era, the victory of Corœbus, the earliest recorded, about 776 B. C., being made the starting point, and the intervals between the games being called *Olympiad.*

101. *Who was Lycurgus?*

Of this personage nothing is known whatever, and some have even denied his existence.   He was the reputed law-giver of the Spartans.   Having obtained for his institutions the approbation of the Delphic oracle, he exacted from his countrymen a promise not to alter them till his return, left Sparta, and was never again heard from.

102. *What was the object of Lycurgus's laws?*

The chief object of the legislation that goes by the name of Ly-curgan was to create and maintain a vigorous and uncorrupted race of men ; it concerned itself with the regulation of private life and physical education.

103. *What was the system of Spartan education?*

Weakly children were exposed to perish.   Great attention was devoted to gymnastic exercises and military drill.   The education of a Spartan, beginning with his seventh year, was not relaxed till his sixtieth.   He was inured to hunger and thirst, and to the extremes of heat and cold, and was taught to endure the keenest bodily torture without complaint.

To teach him strategy and secrecy there were licensed expeditions for thieving, and severe punishment was inflicted on him who allowed himself to be *detected* in it.

104. *What were the laws of Draco?*

Draco, a statesman of Athens, was called upon to draw up a written code of laws for the Athenian government.   They were marked by extreme severity; for he affixed the penalty of death to all crimes alike,—to petty thefts no less than to sacrilege and murder.

Hence Draco's laws were said to have been written, not in ink, but in blood ; and we are told that he justified this extreme hardship by saying " that small offenses deserved death, and that he knew no severer punishment for great ones."

105. *Who was Solon?*

An Athenian law-giver, commissioned to remodel the Constitu-

tion of Athens, 594 B. C. The successful manner in which he performed this work laid the foundation of the happiness of his native country.

106. *What was the institution of ostracism?*

It was a method which the Athenians had devised for the purpose of getting rid of obnoxious public men, and was in some respects a very good plan, as it stopped interminable quarrels between rival politicians.

It derived its name from the fact that the citizens, in voting for its infliction, wrote the name of the objectionable person on a shell (*ostreon*), and if there was a majority of voters for his banishment, he was exiled for ten years.

107. *Give a general summary of Grecian history from the beginning of the Persian Wars to the victory of Philip of Macedon, B. C. 500–338.*

The Ionian Greeks in Asia Minor revolted from Persia, and Athens lent them aid. Accordingly Darius sent Mardonius against Greece; but he advanced no farther than Macedonia, his fleet being destroyed by a storm. Then Darius sent a vast force under Datis, but it was defeated in the battle of Marathon (490 B. C.). Darius having died, his son Xerxes moved on Greece with an immense army and fleet: he was successful at Thermopylæ, and took Athens (480 B. C.); but was defeated at Salamis, and the remaining force at Platæa and Mycale,—which caused the Persian scheme wholly to fail.

The half-century following the battle of Salamis was the most brilliant period of Athenian history (age of Pericles); but the greatness of Athens led to the Peloponnesian war (431 B. C.). This was interrupted by the peace of Nicias (421 B. C.); but being renewed, the Athenians were beaten in various engagements, and finally defeated at Ægos Potamos (405 B. C.): so the result of this war was the ascendancy of Sparta. Sparta continued prominent till her defeat at Leuctra (371). Thebes now became for a while the leading state; but Greece, rent by dissensions, was soon subjugated by Philip of Macedon, in the battle of Chæronea, 338 B. C.

108. *Give a brief statement of the battle of Thermopylæ (480 B. C.).*

The Pass of Thermopylæ was a narrow mountain-gorge lying between the precipitous mountains of Œta and a marsh forming

the edge of the Gulf of Malis. The defense of this position was intrusted to the Spartan king, Leonidas, the flower of whose army consisted of 300 Spartans. When the Persian host reached Thermopylæ and sought to force the pass, the Grecian guard made a stout defense and for two days kept the enemy at bay; but on the third day a traitor pointed out to the Persian king how, by taking a mountain-path, the position of the Greeks might be "turned." When this movement became known, Leonidas and his three hundred Spartans, with seven hundred Thespians, determined to sell their lives as dearly as possible: so they advanced into the open space in front of the pass and charged the Persians with desperate valor. But this heroism was in vain; for the enemy, pouring in from front and rear, surrounded the Greeks on all sides. Leonidas fell, and the heroic band were killed to a man.

109. *Give a general summary of Grecian history from the victory of Philip to the absorption of Greece by the Romans, B. C. 338–146.*

Philip of Macedon by war and intrigues made himself master of Greece, and was then appointed general-in-chief against Persia; but he died, and his son Alexander took up the task (336). He marched against the Persians in Asia Minor, defeating them in the decisive battle of Arbela (331). He afterwards marched eastward to beyond the Indus, and thence returned to Babylon, where he died (323). After Alexander's death his generals disputed, and the empire was divided. Greece, meanwhile, fell into a state of intestine war, and at last became a Roman province (146 B. C.).

110. *What contribution did Greece give to the world's civilization?*

The practical example of free, self-governing states. The Greek states gave an illustration of democracy,—"the government *of* the people, *for* the people, *by* the people."

In the Oriental nations the only government was despotism: there was an absolute lord, and there was a mass of subjects, or *slaves*, but no *people* in a political sense.

111. *What was the religion of the Greeks?*

They were polytheists. Their religion received its peculiar form from the fictions of the poets, especially of Homer and Hesiod.

In the Grecian *theogony*, or history of the gods, the earliest events that are described are the proceedings of certain gigantic agents,—the collision

of certain terrific forces, which were ultimately reduced under the more orderly government of Zeus, or Jupiter, with whom begins a new dynasty, and a different order of beings.

112. *What were the names and the chief attributes of the Olympian gods?*

(1) **Zeus,** or *Jupiter*, the chief and father of the gods. He is always represented as seated on a throne with the thunderbolts in his right hand, and an eagle by his side.

(2) **Po-sei'-don,** or *Neptune*, the earth shaker and ruler of the sea: his symbol is a trident.

(3) **A-pol'-lon,** or *Apollo* (called also Phœbus Apollo), the divinity of poetical inspiration, of song and music. He was figured as the *beau ideal* of manly beauty.

(4) **Ar'-te-mis,** or *Diana*, the huntress among the immortals, the divinity of flocks and of the chase. As twin sister of Apollo, she was the divinity of the moon.

(5) **He-phais'-tas,** or *Vulcan*, the god of terrestrial fire: he is represented as a blacksmith.

(6) **Hermes,** or *Mercury*, the messenger of the gods; the god of eloquence and the protector of trade: he is marked by his winged sandals, and by his wand.

(7) **A'-res,** or *Mars*, the god of war, delighted in the din of battle, the slaughter of men, and the destruction of towns.

(8) **He'-ra,** or *Juno*, the wife of Jupiter, a beautiful but unamiable goddess.

(9) **A-the'-na,** or *Minerva* (also *Pallas*), the goddess of wisdom and war.

(10) **Hes'-tia,** or *Vesta*, the goddess of the hearth.

(11) **De-me'-ter,** or *Ceres*, the goddess of agriculture.

(12) **Aph-ro-di'-te,** or *Venus*, the goddess of love and beauty, is generally represented with her son **E'-ras,** or Cupid. The legend runs that she rose from the sea-foam and landed on the island of Cyprus.

113. *What were the four Grecian national festivals?*

The Olympic, Pythian, Isthmian, and Nemean Games.

The Olympic Festival was celebrated in honor of Jupiter in the plain of Olympia, every four years; the Pythian was held in the third year of each Olympiad, near Delphi, in honor of Apollo; the Isthmian, in honor of Neptune, was so called from its being celebrated on the Isthmus of Corinth; the Nemean, in honor of Nemean Jupiter, at the town of Nemea in Peloponnesus.

114. *Who were the great Grecian poets?*

Homer, author of the oldest Greek poems—two immortal epics,— namely, the *Iliad* and the *Odyssey*. These are considered the finest narrative poems ever written.

Hesiod, who lived about a century after Homer. His two most famous books are the *Theogony* and the *Works and Days*, both epics.

Tyrtæus, one of the most famous writers of the elegy, wrote stirring campaign songs.

The most famous names in Greek *lyric* poetry are **Sappho, Alcæus, Anacreon,** and **Pindar.**

115. *Who was the most famous writer of Greek comedy?*

Aristophanes, author of *The Clouds, The Wasps, The Birds,* and *The Frogs.*

116. *Who were the most noted dramatic Grecian poets?*

Æschylus, Sophocles, and **Euripides.**

117. *Who were the most celebrated Greek historians?*

Herodotus, called the "Father of History," stands pre-eminent. His subject was the History of the Persian Wars.

Thucydides was the most *philosophic* historian.

Xenophon, a contemporary of Thucydides, was an easy and graceful writer.

118. *Who was the most eminent writer of biography?*

Plutarch, whose *Lives* has been called the "Bible of heroism," lived in the 2d century, A. D.

119. *Who were the most celebrated Grecian orators?*

Pericles, whose sublime oratory gained for him the epithet of "the Olympian."

Political oratory was exhibited in its fullest development in the contest between **Æschines** (393–317 B. C.), the advocate of Macedonian interests, and his greater adversary **Demosthenes** (385–332 B. C.), who, in exposing and opposing the plans of Philip, "shook the arsenal and fulmined over Greece."

120. *Who were the early Greek philosophers?*

Thales, founder of the Ionic school ; and **Pythagoras,** the head of the Pythagorean school.

121. *Who was Socrates?*

He was one of the wisest and greatest of the human race. His special work was to break down prejudices, to show people their ignorance, to expose fallacies, and to assert the existence of great necessary truths,—of the good, the true, and the beautiful,—and this he did by a method of searching inquiry called after him, the *Socratic.*

Notwithstanding his pure and noble life, and his efforts to promote the welfare of mankind, his doctrines made him many enemies : he was charged

before the Athenian magistrates with not believing in the gods, and with being a corruptor of youth. Being condemned on these charges, he met his death calmly, surrounded by his beloved and weeping disciples, to whom, in his last hours, he discoursed on the Immortality of the Soul.

122. *Who was Plato?*

He was one of the disciples of Socrates, and founder of the Academic school, so called from the groves of Academus, near Athens, where the philosopher gave his lectures. The works of Plato remain in the form of his *Dialogues.*

123. *Who was Aristotle?*

He was the founder of the Peripatetic school, and the most logical and systematic of the philosophers and scientists of Greece. He was the teacher of Alexander the Great.

124. *What were the three classic forms of Grecian architecture?*

The DORIC, the IONIC, and the CORINTHIAN.

The most famous of the Doric temples of Greece is the Parthenon; the most celebrated example of the Ionic order was the temple of Diana at Ephesus, burnt on the birth-night of Alexander the Great. The Corinthian was the highest and most richly ornamented of the Grecian orders.

125. *What can be said of Grecian sculpture?*

It is acknowledged that in sculpture the Greeks attained absolute perfection. The specimens that remain to us embody the very perfection of loveliness, majesty, and power.

126. *When was Rome founded?*

In the year 753 B. C. Tradition hands down the names of seven kings who ruled Rome during the regal period (753–509 B. C.); but great obscurity hangs around the greater part of this epoch.

127. *What were the two classes of Roman society?*

Patricians and Plebeians, a distinction of great importance in Roman history.

During the early ages the Patricians alone constituted the *Populus,* or people, in a political sense.

128. *What was the historical extent of the Roman republic?*

The history of Rome as a republic covers a period of 482 years,— from the termination of kingly rule, 509 B. C., to the termination

of republican rule by the establishment of the empire under Augustus, 27 B. C.

√ **129.** *What were the four Epochs of the Roman republic?*

I. Epoch of the Struggle for Existence, beginning with the establishment of the republic and ending with the Gaulish invasion of Italy, 509–390 B. C.

II. Epoch of the Roman Conquest of Italy, from the Gaulish invasion to the complete subjugation of the peninsula, after the repulse of Pyrrhus, 390–266 B. C.

III. Epoch of Foreign Conquest, including the Punic and Macedonian wars down to the beginning of civil strife under the Gracchi, 266–133 B. C.

IV. Epoch of Civil Strife, from the Gracchi to the establishment of the Empire under Augustus, 133–27 B. C.

130. *Mention some of the great names of early Rome.*

Lucius Junius Brutus, known as the "Elder Brutus," noted for his inflexible justice; Cocles Horatius, celebrated for his heroic "defense of the bridge"; Caius Marcius, surnamed Coriolanus, noted for his valor at the capture of the Latin town of Corioli; Lucius Quintius Cincinnatus, the noble dictator.

131. *What were the Tribunes of the Plebs?*

They were magistrates, chosen from the Plebeians. They held office for a year, during which their persons were sacred, and they could nullify any decree of the Senate that they thought injurious to the Commons by the word VETO, *I forbid it.*

132. *What were the Decemvirs?*

A Council of Ten, appointed to make laws.

133. *Who were the Censors?*

They were magistrates who held the power of determining the rank of every citizen, of fixing his status in society, and valuing his taxable property.

134. *What were the conquests of the Roman republic?*

The "Samnite" and the "Latin" wars ended in the subjugation of these nations and the mastery of Rome over all Central

Italy. The Romans finally obtained mastery over the whole Italian peninsula.

135. *What were the three great wars of foreign conquest?*

The First, Second, and Third, Punic Wars. These were waged between Rome and Carthage, resulting in the utter annihilation of the Carthaginian power.

136. *Who was the greatest military commander of the Carthaginians?*

Hannibal, who was one of the greatest military geniuses that ever lived. His climbing over the Alps with an army of 30,000 men to defeat the Romans was one of the most famous exploits on record.

137. *Who commanded the Romans against Hannibal?*

Scipio *Africanus,* who compelled the Carthaginians to agree to a peace on very severe terms.

138. *Who were the Gracchi?*

The cause of the poor against the rich was taken up by a noble young tribune of the people named Tiberius Gracchus. Tiberius and his younger brother Caius (the two being known in history as the Gracchi) were sons of a noble Roman matron, Cornelia, daughter of the great Scipio Africanus.

139. *What was the Agrarian law proposed by the Gracchi?*

It limited the amount of public land that could be held by any one individual.

140. *Who was Pompey?*

He was a noted Roman warrior and consul. He had been the leader of the aristocracy, but went over to the people's party, and with Julius Cæsar and Crassus, formed the First Triumvirate.

141. *What were the four factions in Rome?*

The "oligarchical faction," which directed the Senate; the "aristocratic faction," comprising the mass of the senators; the "Marian party," including those whose families had been perse-

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cuted; the "military faction," embracing old military officers who had squandered the fortunes gained in time of war.

142. *Who were the respective leaders of these several factions?*

Of the oligarchy, Marcus Tullius Cicero, who had established his reputation as the first orator in Rome; of the aristocratic faction, Crassus, whose immense wealth made him influential; the leader of the third, or Marian party, was Caius Julius Cæsar, a man of pre-eminent ability, one of the greatest that ever lived; the leader of the military faction was Catiline, who had a large following of debauched young patricians and ruined military men.

143. *What was the conspiracy of Catiline?*

The ruined military men thought they would better their fortunes by making Catiline consul. Cicero was his rival, and, receiving the support of the senators, was elected. Enraged at his defeat Catiline formed a conspiracy of which the murder of Cicero and the burning of Rome were parts. A woman betrayed the plot to Cicero, who denounced Catiline with such fiery eloquence that he had to flee from Rome. With a band of confederates he attempted to reach Gaul; but he was overtaken and slain.

144. *What were the Commentaries of Cæsar?*

During the years 58–50 B. C., Cæsar made eight campaigns in Gaul, forming the remarkable series of operations which he afterwards described with such pointed style in his *Commentaries*, or history.

145. *What brought about the rivalry between Cæsar and Pompey?*

After the death of Crassus (who with Pompey and Cæsar formed the triumvirate), the triumvirate became a duumvirate, or league of *two* men,—Cæsar and Pompey. Owing to contrasted dispositions, a feeling of rivalry caused them to become bitter enemies. Pompey went over to the aristocratic party, and having been made sole consul he exerted his great influence against Cæsar.

146. *What is implied in the expression " crossing the Rubicon"?*

The crossing of this river was in reality a declaration of war against the Roman republic. In the war between Pompey and

Cæsar, it is related that, upon arriving at the Rubicon, Cæsar long hesitated whether he should take this irrevocable step. After pondering many hours he at length exclaimed, "The die is cast!" and plunged into the river.

147. *What was the result of the war between Cæsar and Pompey?*

Pompey was defeated and Cæsar became master of all Italy; had himself appointed dictator and consul for the year 48 B. C.

The decisive battle between the two mighty rivals was fought at Pharsalia. It resulted in the utter defeat of Pompey; and as it left Cæsar the foremost man in the Roman world, it must be regarded as one of the great decisive battles of history.

148. *What was the fate of Pompey?*

After his defeat, he sought refuge in Egypt; but he was assassinated by the orders of Ptolemy, when seeking to land on the coast of that country.

149. *What of Cæsar and Cleopatra?*

At Alexandria Cæsar became bewitched by Cleopatra, the young, beautiful, and fascinating queen of Egypt. He mixed himself up with a quarrel going on between her and her younger brother Ptolemy, to whom, according to the custom of the country, she was married, and with whom she shared the throne. Cæsar was thus brought into conflict with the king's troops, and was finally successful: Ptolemy was killed, and Cleopatra was made queen of Egypt.

150. *What was the conspiracy against Cæsar?*

The chiefs of the conspiracy were Caius Cassius and Marcus Junius Brutus. Both had received great favors from Cæsar; but they thought they had not been honored enough, and they were intensely jealous of the dictator's greatness. These were joined by other malcontents, and the conspiracy finally included about sixty senators.

151. *Give an account of the assassination of Cæsar.*

The conspirators fixed on the Ides (*i. e.* 15th) of March as the time of putting the design into execution. Cæsar disregarded the warnings of his friends, and attended the Senate. As soon as he had taken his place he was surrounded by the senatorial conspirators, one of whom, pretending to urge some request, seized his toga with both hands and pulled it violently over his arms. Then Casca, who was behind, drew a weapon and grazed his shoulder with an ill-directed stroke. Cæsar disengaged one hand and

snatched at the hilt, exclaiming, " *Cursed Casca, what means this?*" "*Help!*" cried Casca, and at the same moment the conspirators aimed each his dagger at the victim. Cæsar for an instant defended himself; but when he perceived the steel flashing in the hand of Brutus, he exclaimed: " *What! thou too, Brutus!*" and drawing his robe over his face he made no further resistance. The assassins stabbed him through and through; and, pierced with twenty-three wounds, Cæsar fell dead at the foot of the statue of his great rival Pompey.

152. *What was the effect of Cæsar's death?*

It brought on new civil wars, and many claimants for supreme power. The condition of affairs, however, left Mark Antony in some respect the representative of Cæsarean principles.

153. *Who was Julius Cæsar's successor?*

His great-nephew, Octavius Cæsar. Octavius had all the old soldiers on his side, and raised the standard of Cæsar's vengeance.

154. *Trace Roman history from the assassination of Julius Cæsar to the reign of Augustus Cæsar.*

After the death of Cæsar his nephew Octavius formed, with Antony and Lepidus, the Second Triumvirate. Octavius led his forces against Brutus and Cassius, defeating them at Philippi. Antony and Octavius now quarreled, but the dispute was settled in favor of the latter by the battle of Actium, and soon after Octavius assumed the title of Augustus Cæsar.

155. *What was the end of Antony and Cleopatra!*

While making his headquarters at Alexandria, Antony came under the fascinations of Cleopatra, and he lost all regard to his character or his interests in her company. In the conflicts with Octavius Cæsar, Antony was abandoned by his troops, Cleopatra caused a report to be spread of her death. Antony then attempted to commit suicide: hearing, however, in the midst of his agonies, that Cleopatra still lived, he caused himself to be carried to her, and expired in her presence. The Egyptian queen failing to bewitch the cold, calculating Octavius, she, sooner than be led in chains to adorn the triumph of the victor, gave herself voluntary death by the bite of an asp, or the scratch of a poisoned needle.

156. *With whose reign did Rome become an Empire?*

Augustus Cæsar. The senate still sat, but it did little more than vote what Augustus wished.

157. *What was the extent of the Roman Empire?*

The boundaries as established by Augustus were as follows: On the north, the British Channel, the North Sea, the Rhine, the Danube, and the Black Sea; on the east, the Euphrates and the

Desert of Syria; on the south, the Sahara of Africa; and on the west, the Atlantic Ocean.

The Roman Empire took in the modern countries of Portugal, Spain, France, Belgium, Western Holland, Rhenish Prussia, and parts of Baden and Wurtemberg, most of Bavaria, Switzerland, Italy, the Tyrol, Austria Proper, Western Hungary, Crovatia, Slavonia, Servia, Turkey-in-Europe. Greece, Asia Minor, Syria, Palestine, Idumæa, Egypt, the Cyrenaica, Tripoli, Tunis, Algeria, and most of Morocco.

158. *What were the three civilizations of the Roman Empire?*

The Latin, the Greek, and the Oriental. *Latin* civilization took in the countries from the Atlantic Ocean to the Adriatic; *Greek* civilization, from the Adriatic to Mount Taurus; Oriental civilization, the lands beyond to the Euphrates.

159. *What was the population of the Roman Empire?*

Under Augustus, there may have been within the limits of the Empire ONE HUNDRED MILLIONS of human beings.

160. *What was the extent of the city of Rome?*

In the days of its greatest prosperity the circumference—enclosed by walls—was about twenty miles; but there were also very extensive suburbs. The walls were pierced by thirty gates.

161. *What were the most remarkable objects of the city?*

The Coliseum, the Capitol with its temples, the Senate-House, and the Forum.

The great circus, or Circus Maximus, a place reserved for public games, races and shows, was one of the most magnificent structures of Rome. It was capable of containing 200,000 spectators.

162. *Mention some of the distinguished writers of the "Augustian age."*

Virgil, the author of the epic poem, the *Æne'id*, a graceful, if not an original, writer.

Horace, author of many poems, odes, satires, and epistles; a witty, good-humored, and most vivacious song-writer.

Sallust, the historian of the Jugurthine War and the Conspiracy of Catiline; a very spirited writer.

Lucretius, a writer of didactic poetry, containing passages of noble eloquence and philosophy, along with much that is characteristic of the low tone of thought prevalent in the pagan world.

Catullus, author of lyrics that are among the sweetest and most truly poetic things in the Latin language.

163. *Mention some of the subsequent writers in Roman literature.*

Livy, the great historian; **Ovid,** the poet; **Martial,** the writer of epigrams; **Pliny,** the writer on natural history (killed 79 A. D. by the great eruption from Vesuvius, which buried the cities of Pompeii and Herculaneum); **Juvenal,** the bitter satirist; and **Tacitus,** the philosophic historian of the declining glories of Rome.

164. *What remarkable event renders the reign of Augustus Cæsar memorable?*

The birth of CHRIST at the little village of Bethlehem, in Judæa,—the most momentous event in the spiritual history of the world.

165. *When did the birth of Christ take place?*

Reckoned in our common era, this event took place in the year 4 B. C.

Our method of counting time was not introduced till the year 532 A. D. The calculation was erroneous, and it was found ten centuries afterward to be deficient four years of the true period; but as the alteration of a system that had then been adopted by nearly all Europe would have made great confusion in civil and ecclesiastical affairs, the error was, by general consent, allowed to remain, and we continue to reckon from this era (A. D., *anno domini,* that is, "in the year of our Lord"), which, however, lacks four years and six days of the real Christian epoch.

166. *What change made by Constantine had a great effect upon Rome?*

He removed the capital of the empire to the old Greek city of Byzantium, on the Bosphorus, which he greatly enlarged and called *New Rome.*   This was Constantinople.

167. *What were the divisions of the Roman Empire after Constantinople became the capital?*

The Western, or Latin Empire, and the Eastern, or Byzantine Empire.

With the fall of the Western Roman Empire ancient history ends.   This downfall took place in the year 476 A. D.   (See Answer to Question 17.)

168. *What was the state of the world at the birth of Christ?*

All the different peoples and nations under the Roman sway had a great variety of religions, but all, with the exception of the Jews, were pagans and polytheists.

169. *Who first persecuted the Christians?*

Nero. Summing up the several facts, we may say that the persecutions of the Christians were owing to political reasons rather than to religious intolerance.

170. *What were some of the persecutions of Christians during Diocletian's reign?*

He issued an edict (A. D. 303) commanding all Christian churches to be pulled down, all Bibles to be flung into the fire, and all Christians to be degraded from rank and honor.

A Christian of noble rank tore down this proclamation from where it was posted. For this he was roasted to death. Those who refused to burn incense to idols were tortured or slain.

171. *What Roman emperor was converted to Christianity?*

Constantine the Great.

While on the march to attack one of his rivals, near Rome, Constantine is reported to have seen with his own eyes the luminous trophy of the cross in the sky, placed above the meridian sun, and inscribed with the following words: BY THIS CONQUER. In the battle that followed his rival was completely overthrown. It is said that this decided Constantine to be a Christian.

172. *What was the Labarum?*

The standard of the cross, displayed by the Christian emperors in their military expeditions. The top of the *Labarum* was adorned with a mystic ✕, representing at once the cross and the initial of the Greek word for Christ.

It is stated by the early historians that Christ appeared to Constantine in a dream and commanded him to frame the *Labarum*, and under it to march with an assurance of victory against all his enemies.

173. *As a Christian what did Constantine do?*

He repaired the old churches and built new ones; the Christian clergy were freed from taxes; Sunday was proclaimed a day of rest; and Constantinople—a Christian city—was made the seat of government.

174. *Which were the most famous of the Christian Fathers?*

Tertullian, Origen, Cyprian, Ambrose, Athanasius, Gregory, Nazianzen, Chrysostom, Jerome, Augustine.

175. *What were some of the causes of the downfall of Rome?*

Chief of these was the fact that the Romans had really ceased to exist as a nation. The *empire* had absorbed the *nation*. The Roman *race*, which had conquered the world, was finally swallowed up by the world which it conquered. Other causes were alien admixture and demoralizing luxury.

176. *When did the Western Roman Empire fall?*

A. D. 476. About the middle of the 4th century the barbarians began to press Rome very hard. These barbarians were Goths, Vandals, Huns, and other tribes which emigrated in hordes from the East and North. Rome was taken and sacked by the Goths 410 A. D., and again by the Vandals 455 A. D. In 476 A. D., the last emperor, Augustulus, was dethroned and his dominion assumed by the Gothic General Odoa'-cer, with the title of king.

MEDIEVAL HISTORY.

177. *The time elapsed since the fall of Rome may be how divided?*

Into two parts: The first part constitutes what is usually called the *Middle Ages*,—embracing one thousand years; that is, it extends from about the close of the 5th to the close of the 15th century of our era. From the close of the 15th century down to the present time is modern history in its narrowest sense.

178. *What comprise the historical races of Europe?*

They comprise four grand divisions of the great Aryan stock,— the Græco-Latins, the Celts, the Teutons, and the Slavonians.

179. *What was the order of their migration?*

The ancestors of these races came originally from Asia. The first wave of migration brought the Celts, who established themselves in Central Europe. The incoming Teutons drove them into Western Europe, and possessed themselves of Central and Eastern Europe. At a subsequent date the Slavonic race made their appearance in Europe; and the effect of this was that the Teutons were wedged into Central and Northwestern Europe, while the Slavonians overspread the whole of the great Eastern plain.

180. *What was the influence of Rome on the Celts?*

Of the three races the Celts first came in contact with the Romans. The result of this contact was that the Celtic population had become thoroughly Latinized and Christianized before the breaking up of the Western Empire.

181. *Of what is modern society the result?*

Of the blending of Teutonic, or Germanic, barbarians with the Latin and Celtic elements.

It derives ingredients from both,—from the barbarians the love of personal liberty and the sense of independence, from the Romans the forms of a long established civilization.

182. *What terms designate the central family of Europe?*

The terms Teutonic, Gothic, Germanic are all used as synonymous, and are employed indifferently to designate this mighty central family.

183. *What were the chief Germanic tribes?*

The Goths, the Franks, the Vandals, the Burgundians, the Lombards, the Saxons, the Angles, and the Scandinavians.

184. *What were the languages of the new nations that arose on the ruins of the Roman Empire?*

Romance Languages { ITALIAN, FRENCH, SPANISH. **Germanic and Romance** } ENGLISH.

Germanic {
HIGH GERMAN, or the tongues of Southern Germany,—the "German" of our day.

LOW GERMAN, the tongues spoken by the dwellers in Northern or sea-coast Germany, represented by the Dutch of our day.

SCANDINAVIAN, including the SWEDISH, DANISH, NORWEGIAN, and ICELANDIC.
}

Celtic { Gaelic SCOTCH, ERSE of Ireland.

Slavonian { RUSSIAN, POLISH.

185. *What was the Byzantine Empire?*

The Eastern Empire of Rome, which, though in a state of premature and perpetual decay, continued to subsist for a thousand years after the downfall of the Western, or Latin, Empire.

186. *When was the Byzantine Empire in the meridian of its glory?*

In the 6th century during the long reign of Justinian, A. D. 527–565.

187. *When was the beginning of France?*

When Clovis, King of the Franks, fixed his capital at Paris, in A. D. 507.

188. *Who was Charles Martel?*

He was a prime minister styled the Mayor of the Palace,—an officer chosen by the nobles to be the guide and controller of the sovereign. He upheld the Frankish power most vigorously, and by his defeat of the Saracens in A, D. 732, saved all Europe from being subjugated by Mohammedan rule.

189. *What were the beginnings of England?*

The Roman troops had been withdrawn from the province of Britain about half a century before the downfall of Rome, and the Britons, who belonged to the Celtic race, were left to shift for themselves. About the middle of the 5th century various Teutonic tribes from the Low-German lands, invaded Britain, and the native Celtic Britons were killed, enslaved, or driven to the mountain regions of Wales aud North Britain.

Among the Low-German invaders were three main tribes,—the Angles, Saxons, and Jutes. The name *Jute* has left no memorial in England; but the English people are still often spoken of as belonging to the *Saxon* race, while the speech which arose in the island from the intermixture of the various German dialects took the name of *Anglo-Saxon*, and Britain changed its name to *England*, or the land of the *Angles*.

190. *Give a brief sketch of Mahomet.*

Mahomet, or Mohammed, was born at the sacred city of Mecca, in Arabia, in the year 570 or 571. Till the age of forty he lived without exciting much remark, and was known only as an able, rich, and enterprising merchant, honorable in his dealings, and strictly truthful in all that he said. He could neither read nor

write; but his mercantile journeys to various parts of the peninsula, as well as to Syria and Palestine, had enlarged his store of information.

In his frequent retirements to a mountain cave for secret thought and study, he developed a religious system of his own. He one day, at a meeting of his kinsmen, made the startling announcement that he had received a Divine commission to reform the faith and practice of the whole Arabian nation.

191. *What were the Koran, and the Hegira, respectively?*

The *Koran* contained the doctrines of Mohammed, written down from time to time ; the *Hegira* was the date of Mohammed's flight from Mecca,—July 15, 622 A. D.

192. *Who were the Caliphs?*

Successors of Mohammed, the first of whom was his father-in-law, Abu-beker.

193. *By what means was Mohammedanism spread?*

By a long series of invasions, wars, and conquests. They everywhere gave men the choice of three things,—Koran, tribute, or sword.

By this means the religion of Mohammed was spread over a large part of Asia and Africa, and made its way even into Europe.

194. *Who was Charlemagne?*

He was the son of Pepin, the first of the Carlovingian monarchs. He was born about A. D. 742. His real name was Karl, that is, Charles (Charles the Great).

195. *What was the Kingdom of Charlemagne?*

It comprised portions of the two countries we now call France and Germany.

196. *What was Charlemagne's design?*

His ruling idea was the re-establishment of the Roman Empire.

It was in the effort to realize his grand idea that Charlemagne undertook the numerous wars and expeditions that filled the forty-six years of his reign.

197. *When and by whom was Charlemagne crowned emperor?*

A. D. 800. He had gone in splendid state to visit Italy. On

Christmas day he and his court were attending divine service in the church of St. Peter's, at Rome. Suddenly, while the monarch was kneeling on the steps of the altar in prayer, the Pope, Leo III., placed a crown upon his head and solemnly saluted him as "Emperor of the West," with the title of Charles I., CÆSAR AUGUSTUS.

198. *What was the character of Charlemagne?*

In activity, in a craving desire to be ever doing something, he resembled Napoleon. He was a great patron of learning and learned men, and fond of literary pursuits himself. In his habits he was plain and unostentatious.

199. *What was the Feudal System?*

It sprang out of the peculiar relations of man to man among the various Teutonic tribes who obtained possession of the countries that had formed the Western Empire.

Every free German who had helped his chief in conquering the country received as his share of the spoil a particular estate, which was called his *allodium*, or *freehold*,—this estate being absolutely his own property. The chief or king received a very large domain as *his* share. After a time it became usual for him to grant portions of this, his own domain, to his followers and favorites, on condition of their being faithful to him and doing him service in war. The land so granted was called a *feudom*, or *fief*, and land held in this way was said to be held by a *feudal tenure*.

Land held by the feudal tenure was not the soldier's property by right, but was retained only during the pleasure of the real owner, and so long as the conditions agreed on were lived up to. The real owner was the *lord*, or *liege*, while the person to whom he granted the land was called his *vassal*, *liegeman*, or *retainer*.

200. *What were serfs?*

Though they were not actual *slaves*, yet they were bound to the land, and passed with it when *it* changed hands.

201. *What were the effects of feudalism?*

The mass of the people had no guaranteed rights. The feudal barons grievously oppressed them, and as the nobles were the *magistrates* of the fiefs, the people had no redress. The system was a reign, not of *law*, but of *lawlessness*.

It was a system that was not wholly bad : it must have been in some degree adapted to the times, otherwise it could not have existed at all ; but it belonged to a state of society essentially barbarous, and it was overthrown by that very *civilization* which it could not keep from growing up in its very midst.

202. *What was the Roman bishop, or pontiff, called ?*

The name "pontiff" means the chief officer of the old pagan religion of Rome. He was called *Pater*, or *Papa*, father (whence English *Pope*). The modern style is "His Holiness the Pope."

203. *Into what two divisions was the Church of Rome split ?*

Into the Eastern, or *Greek Catholics*, and the Western, or *Roman Catholics*. The head of the Greek church is the *patriarch* of Constantinople.

204. *What of the power of Papacy ?*

The origin of the *temporal* power of Papacy was based on a grant to the Pope by Charlemagne, A. D. 800. For several centuries the Pope was almost the arbiter of Europe. Kings trembled at incurring his displeasure, and dreaded the terrible consequences of a "bull" of excommunication. The *temporal* power of the Pope ended in 1870, when Victor Emmanuel, King of Italy, took possession of the "States of the Church." The Pope remains a *voluntary* prisoner in the Vatican Palace.

After the Reformation the influence of the Papacy gradually declined. Even Catholic powers assisted the enemies of the Pope when it was to their advantage.

205. *What was the object of the Crusades ?*

The Crusades (*war of the cross*) were undertaken by the Western nations of Europe for the recovery of the Holy Land from the Saracens and Turks.

206. *Who aroused this feeling ?*

An enthusiastic monk called PETER THE HERMIT, a native of Amiens, France. He followed the wars in his youth, then became a monk, afterwards retired to absolute solitude, and finally made a pilgrimage to Jerusalem. There witnessing the cruelties of the Turks, he became possessed with the idea that he was inspired by Heaven to deliver the Holy Sepulcher from their hands.

Two *councils* of the church were called and a crusade was determined on, 1095. It was agreed that a *red cross* worn on the breast or shoulder should be the badge of the crusaders.

207. *How many Crusades were made to the Holy Land?*

Eight; the first three being called the Greater Crusades. The First Crusade (A. D. 1096–1099); the Second Crusade (A. D. 1147–1149); the Third Crusade (A. D. 1189–1192).

208. *Who were the most distinguished leaders of the Crusades?*

Peter the Hermit; Walter the Pennyless; Godfrey of Bouillon (Duke of Lower Lorraine); Robert (Duke of Normandy); St. Bernard; Conrad III. (Emperor of Germany); Louis VII. of France; Richard I. of England, known as Richard Cœur de Lion (Lionhearted); Philip Augustus of France; and Frederick Barbarossa (Red Beard), Emperor of Germany.

209. *Who were the most distinguished leaders of the Saracens?*

Solyman (Sultan of Turkey); and Saladin.

210. *What was the result of the Crusades?*

They utterly failed in their immediate object,—the recovery of the Holy Land from the Mohammedans.

211. *What were some of the important effects of the Crusades?*

(1) A prosperous and permanent commerce arose.

(2) The intermingling of so many different nations tended to break up *local* prejudices.

(3) They diminished the strength of the feudal aristocracy, by occasioning the breaking up and sale of many feudal properties.

(4) Chivalry, though older than the Crusades, derived its chief influence and strength from these wars.

(5) They promoted the diffusion of knowledge by bringing the civilization of the Saracens and Greeks in contact. From the time of the Crusades a great intellectual revival began throughout all Europe.

212. *What was the origin of Chivalry?*

Chivalry had its origin in two peculiarities in the customs and instincts of the Gothic races,—the great honor paid to the profession of arms, and the high regard and delicate gallantry of the

Teutons towards the female sex. Feudalism became a regular system in the 11th century.

213. *What, respectively, was the training of a page, a squire, and a knight?*

The sons of a lord's vassals were sent to the castle to receive training in military exercises and the etiquette of the times. From the ages of seven to fourteen these boys were called *pages*. The page associated with the ladies, who, with their knights, taught him courtly manners by precept and example. At the age of fourteen the page became a *squire* and attached himself to some knight as his assistant. At twenty-one the squire, if worthy, became a *knight*. He vowed that he would be a champion of the church, a protector of woman, and a redresser of wrong.

214. *What was the characteristic amusement of chivalry?*

The tournament. The contesting knights fought on horseback in the lists, in the presence of the royal household and the gentry of the vicinity.

Each knight usually selected some lady to whom he vowed perpetual constancy, and in whose name he went forth to win renown.
From the descriptions of *tournament* scenes that we read in the pages of Sir Walter Scott, or of the old chronicler Froissart, it is evident that the *tourney* must have surpassed every scenic performance of modern times.

215. *What were some of the influences of chivalry?*

It inculcated gentle manners, respect for the female sex, and charity toward the helpless.

Some of its practices degenerated into absurdities. (See Cervantes's *Don Quixote*.)

216. *Why is the period of the Middle Ages called the " Dark Ages?"*

Because of the reign of ignorance and superstition.

Learning was almost exclusively confined to the clergy and the monks. Even kings could not write their own names. To the monks we owe much that is preserved of ancient knowledge.

217. *What was the chief cause of the general ignorance of the " Dark Ages?"*

The scarcity of books. The art of making paper from cotton rags was not introduced till about the close of the 11th century. Previous to this the two kinds of writing material were papyrus

and parchment. In the 7th century papyrus almost ceased to be imported into Europe; while parchment was too costly to be readily spared for book purposes.

218. *Who were the eminent men of the Dark Ages?*

During the five centuries of this age, we find but few names of really eminent men. Bede, the Englishman; Alcuin, also an Englishman; John, surnamed Scotus or Erigena, a native of Ireland; and Pope Sylvester.

219. *What distinctions and customs prevailed during the Middle, or Dark Ages?*

The upper class owned everything, and the people were little better than slaves. Horrible atrocities were usually committed in war.

220. *What conveniences of life came into use during the Middle Ages?*

They were few and simple. *Chimneys* came into use about the 15th century. *Glass windows* were introduced into England in the 12th century. Time was measured by means of sun-dials.

221. *What were the only really great works of the Middle Ages?*

The cathedrals. Some of the most noted of these great churches are the cathedrals of Strasburg, Milan, Cologne, St. Peter's at Rome, and St. Paul's at London.

222. *What was the age of revival from the state of degradation and poverty of the Middle Ages?*

The commencement of this restoration may be dated from about the close of the 11th century.

We can not apply the term "Dark Ages" to the period between the 11th and the 15th centuries,—for at this time we see the shadows grow fainter as we advance, till finally the twilight reddens into our modern dawn.

223. *What were signs of revival?*

(1) The springing up of walled cities; (2) The popularity of the great universities: University of Oxford, University of Bologna, and the University of Paris; (3) The dawn of a new literature in French, Spanish, Italian, and German about the time

of the Crusades, — CHAUCER, the father of English literature, was born 1328; (4) The mariner's compass, gunpowder, and cannon came into use early in the 14th century.

The invention of *printing* from movable types is claimed both by the Dutch and Germans.

224. *What was the "scholastic philosophy" of the 11th and 12th centuries?*

The chief feature of this was the application of the art of dialectics to subtle questions of metaphysics and theology.

225. *Who were the great masters of this art?*

They are known collectively as the Schoolmen. The most famous were Thomas Aquinas, Dun Scotus, Roscelin, Anselm, and Peter Lombard.

Many of the questions which the Schoolmen discussed with great interest now seem very frivolous,—as, for instance, the question as to "how many angels can stand on the point of a needle?" and whether "an angel in passing from one point to another passes through intermediate space?"

226. *What two eminent scientists lived in the 13th century?*

Roger Bacon, an English monk, and Albertus Magnus.

For the times in which they lived these men made wonderful advances in true knowledge; and each had to pay the penalty of being in advance of his age, for both were punished as magicians.

227. *For what are we indebted to the Saracens of the Middle Ages?*

We received from them our mode of notation, called the Arabic figures; and the terms "algebra," "alcohol," "alchemy," "zenith," "nadir," etc., all of which are Arabic. To the researches of the Saracenic alchemists we owe the beginnings of chemistry. The first work on chemistry was written by Geber, an Arab of the 8th century.

228. *What are the most famous collections of the heroic poetry of the Middle Ages?*

The German collection known as the *Nibelungen Lied;* the Spanish romance of the *Cid;* and the cycle of poetry relating to the British Arthur and his Knights of the Round Table.

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229. *When were the real beginnings of our modern literature?*

In the 13th century we have in Italy DANTE (born A. D. 1265), whose *Divine Commedia* is one of the great world-books; and in the 14th century our own English CHAUCER (born A. D. 1328), who is still accounted one of England's five greatest poets.

230. *What three states grew out of Charlemagne's Empire?*

Germany, France, and Italy.

For almost a century after Charlemagne's death the chief power was in the hands of certain dukes.

231. *Who was the first line of German emperors?*

Henry I., or the Fowler. He was the first of a series of five Saxon emperors who ruled Germany for more than a century, and raised it to be the greatest power in Europe.

232. *When was the revival of the Western German Empire?*

Under Otho the Great (A. D. 936). Its title was the "Holy Roman Empire of the German Nation."

233. *When was the real beginning of France?*

In the 10th century. When Gaul was conquered by the Franks it became a part of the kingdom of the Franks; while under Charlemagne it was a part of *his* extensive Empire.

The Carlovingian line came to an end with Louis the Sluggard; and then in the confusion one of the great dukes, Hugh Capet, Duke of *Francia*, made himself king by right of manhood. Thus the *Duke of Francia* became *King of France*, and this was the real beginning of the kingdom of FRANCE, A. D. 987.

234. *Under Louis IX. (Saint Louis) what was the condition of France?*

His wise rule gave France increased importance; at this time (1226 A. D.), she began to be a great nation, and she was henceforth reckoned amongst the foremost powers of Europe.

235. *What was the Hundred Years' War?*

Edward III. of England thought he should have the crown of France, and accordingly he fitted out a great armament by sea and land to wrest that crown from Philip of Valois (Philip VI.).

There thus began a great war, called in French history, the *Hundred Years' War.*

The most famous events in this series of wars were:
(1) Battle of Crecy (A. D. 1346): English victory,
(2) Battle of Poitiers (A. D. 1350): English victory.
(3) Conquest of Aquitaine by the French.
(4) Battle of Agincourt (A. D. 1415): English victory.
(5) Refusal of the French to acknowledge the treaty after the death of both Charles and Henry in A. D. 1422.
(6) Uprising of France, under the inspiration of the famous Maid of Orleans, Joan of Arc.
Finally, by the year 1453, the English were entirely driven from France. This ended the Hundred Years' War.

236. *What was the effect of the Norman Conquest of England?*

The Norman conquest of England, under William the Conqueror (A. D. 1066), thoroughly subjugated the English. The Church and the law courts were directed by the conquerors; the official language was Norman-French.

237. *Who were the Norman kings?*

William I. (A. D. 1066–1087).
William II. (Rufus) (A. D. 1087–1100).
Henry I. (A. D., 1100–1135).
Stephen (A. D. 1135–1154).

238. *Who were the Plantagenets?*

Henry II. (A. D. 1154–1189).
Richard I. (A. D. 1189–1199).
John (A. D. 1199–1216).
Henry III. (A. D. 1216–1272).
Edward I. (A. D. 1272–1370).
Edward II. (A. D. 1307–1327).
Edward III. (A. D. 1327–1377).
Richard II. (A. D. 1377–1399).

239. *In whose reign was the Magna Charta granted?*

The English people in A. D. 1215 forced King John to grant the Great Charter (*Magna Charta*), by which all the old rights and good laws which he had broken were confirmed. It has been the groundwork of English freedom ever since.

240. *When and how was the English Parliament established?*

It came about in this way: The King, Henry III., John's son,

had behaved badly. The great nobles, with Sir Simon Montfort, banded against the King, defeated him in the field, and made him captive. Then Sir Simon issued writs which added to the old assembly of lords, clergy, and knights *two burgesses* from each borough (A. D. 1264). This was the commencement of the English House of Commons, and of true representative government.

241. *Who were the Lancastrian Kings of England?*

With the deposition by Parliament of Richard II., A. D., 1399, the Plantagenet line went out. Three kings of the House of Lancaster now followed: Henry IV. (A. D. 1399–1413); Henry V. (A. D. 1413–1422); Henry VI. (A. D. 1422–1461).

242. *What were the Wars of the Roses?*

In A. D. 1455 there broke out the great civil strife known as the Wars of the Roses (the *red* rose, symbol of Lancaster, and the *white* rose, symbol of York), the contending parties being the respective representatives of the families of Lancaster and of York, both of which were claimants to the throne. Six years of war resulted in the accession of Edward IV., of the family of York.

243. *Who were the Kings of the House of Lords?*

Edward IV. (A. D. 1461–1483); Edward V. (A. D. 1483–1483); Richard III. (A. D. 1483–1485).

The twenty-four years' reign of these three kings was filled with troubles and intrigues, and these continued till A. D. 1485, when a Lancastrian earl, son of Edward Tudor, came to the throne as Henry VII. With him the Tudor line of English sovereigns begins, and English medieval history ends.

244. *What can be said of Venice during the Middle Ages?*

Ship-building was on a large scale, and the hire of vessels to carry the Crusaders to Palestine filled her coffers with gold. Her ships brought back from Syria the silks and spices and jewels of the East.

245. *Who were the Medicis?*

They were merchants who rose to great influence in Florentine politics. One of them, Lorenzo de Medici, raised himself to be the head of the State.

His splendid patronage of art and literature gained for Lorenzo the name of the Magnificent. He turned his gardens at Florence into an academy, he enriched the public library with many hundreds of manuscripts col-

lected in Italy and the East, and by his patronage of artists made Florence the scene of some of the most brilliant triumphs ever won by brush or chisel.

246. *What Spanish kingdoms arose in the Middle Ages?*

The Kingdom of Navarre was founded in A. D. 873, the Kingdom of Aragon in A. D. 1035, the Kingdom of Castile in A. D. 1026. Leon and Asturias were added in A. D. 1037, and Ferdinand of Leon and Castile added Cordova, Toledo, and Seville between A. D. 1234 and A. D. 1248.

247. *How was the Kingdom of Spain formed?*

By the union of Castile and Aragon, by the marriage of Ferdinand and Isabella, and in 1491, Grenada was wrested from the Moors.

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248. *What was the power of the Ottoman Turks?*

Not only did nearly all Asia Minor fall under Turkish sway, but in the 14th century the Turks crossed the Hellespont, made Adrianople their capital, and reaching out from there gradually stripped the Byzantine empire of Thrace, Macedon, Servia, and Southern Greece.

249. *When and by whom was Constantinople besieged and taken?*

On the 29th of May, 1453, by the Ottoman Turks under Mohammed II. The Turks stormed the walls, having previously battered them with cannon (then used for perhaps the first time); Constantine met the storm valiantly, and for fifty-three days made a stout defense of the city. But Constantine fell, sword in hand, boldly disputing every inch of ground; multitudes of his subjects were massacred; the Crescent waved over the church of St. Sophia, and the Byzantine Empire fell forever.

250. *What was the historic area of ancient and medieval history?*

It was limited to Europe, a small part of Western Asia, and a narrow strip of Northern Africa.

251. *When was the compass practically applied in navigation?*

About the beginning of the 15th century.

The exact time of the invention of the compass is unknown; it is com-

monly attributed to an Italian named Gioja, who flourished about the be-
ginning of the 14th century; but the instrument was known long before by
the Chinese. It was then, however, merely a needle rubbed on loadstone
and floating on a cork, or other light substance, in a vessel filled with
water.

252. *Who were the greatest navigators about the close of the 15th cen-
tury ?*

The Portuguese. They had penetrated the tropics; explored
the greater part of the African coast; made settlements on the
Coast of Guinea; and in 1498, Vasco da Gama doubled the Cape
of Good Hope, thus opening up a sea-route to India.

The circumnavigation of Africa made a complete revolution in the com-
mercial condition of Europe. The trade which had been confined to the
Mediterranean now traversed the Atlantic, and the Western nations hastened
to share in its gains.

253. *What led to the discovery of America ?*

The desire of reaching India by sea was the inspiring motive
that led to the brilliant discovery by Columbus.

Columbus knew that the Portuguese were bending their efforts to reach
India by the circumnavigation of Africa; and his grand inspiration was that
India might more readily be attained by sailing westward across the At-
lantic.

254. *What part in discoveries did England take ?*

In 1497 England sent out John and Sebastian Cabot, who
sailed around the northern coast of Labrador, touched at a point
supposed to have been either Newfoundland or Cape Breton, and
sailed to the south along the coast of what is now the United
States as far as latitude 38°.

255. *When and by whom was the globe first circumnavigated ?*

By the ships of Magellan (1519–1521). He sailed through the
strait which bears his name. At the Philippine Islands (south-
east of Asia), in a contest with the natives, he was killed; but one
of his vessels reached Spain by way of the Cape of Good Hope,
thus making the first voyage around the world.

256. *When was the revival of learning ?*

The fall of Constantinople compelled a great number of learned
Greeks to seek shelter in Italy, and other parts of Western Europe,
carrying with them their treasures of classic lore.

Though long before the fall of Constantinople the love of classical litera-

ture had been gradually reviving, yet there now began among scholars a most ardent search for buried and neglected manuscripts, and their diligence was awarded by the discovery of many precious monuments of the Greek and Roman literature.

257. *What invention was the chief agent in the destruction of feudalism?*

The invention of gunpowder and the consequent change in the art of war; for, neither the armor of the knights nor the thick walls of their castles were proof against bullets and cannon-balls.

Although it is universally conceded that gunpower was invented by Roger Bacon, the English monk, in the 13th century, yet it was long before the invention was applied to the art of war. This application has been claimed for Berthold Schwartz, a German apothecary, about 1330; but gunpowder appears to have been used in war by the Moors before that period.

258. *What is meant by the "States-System of Europe"?*

When the strength of nations becomes centralized in the hands of a few monarchs, it is likely that one of these might through his own power, aided by family connections, gain a great and dangerous preponderance over the others. The aim of the policy named the *balance of power*,—of which we read a great deal in modern European history,—was to attain such a just distribution of force, either by alliance or internal resources between the different states, that none should overshadow the others. This led to exceedingly complicated international relations, and the combination of nations thus formed is often spoken of as the "States-System of Europe."

259. *Who was the Emperor Charles V.?*

He was the son of Philip, Archduke of Austria (son of Maximilian, Emperor of Germany), and of Joanna (daughter of Ferdinand and Isabella of Spain). He was crowned with the diadem of Charlemagne at Aix-la-Chapelle, in the year 1520.

260. *What were the two chief events of his reign?*

(1) The rise of Protestantism; (2) The wars carried on under the lead of Francis I. of France against Charles V., to maintain the balance of power.

261. *What was the position of the Catholic Church at the beginning of the 16th century?*

All the nations of Western Europe were in communion with the Roman Catholic Church.

Soon after the beginning of the 16th century great controversies on matters of religion arose. There was complaint of many practical abuses in the Church, and of the claims of the popes to interfere in the affairs of nations.

262. *Who was Martin Luther ?*

He was Professor of Theology in the University of Wittenberg, took the lead in opposing the Dominican friars, who carried on an extensive sale of *indulgences,* and brought about the Reformation (1517).

263. *What were indulgences ?*

Remissions of the penances imposed upon persons whose sins had brought scandal on the community. But in process of time they were represented as actual pardons of guilt, and the purchaser of indulgence was said to be delivered from all his sins.

264. *How were the doctrines of the Reformation generally received ?*

They took deep root in Germany, France, Switzerland, England, Scotland, and Scandinavia.

Allowing for considerable exceptions, the nations of Teutonic stock embraced the new doctrines, while most of the Latin race adhered to the faith of Rome.

265. *What was the origin of the name Protestant ?*

It was originally applied to those who adhered to Luther at the Reformation in 1529, and *protested* against, or made a solemn declaration of dissent from, a decree of the Emperor Charles V. and the Diet of Spires, and appealed to a general council.

266. *What were the political events of Charles V. ?*

The complications with Francis I. of France. This bitter rivalry led to four wars, in each of which the avowed object of Francis was to preserve the balance of power, as against the menacing greatness of the House of Austria, represented by Charles V.

Charles V. was also engaged in a contest with the Protestant princes of Germany, who had formed a league for their mutual protection, in 1531.

A great council, called the *Council of Trent,* was convened against Protestanism in 1545. At the very commencement of the war, Maurice of Saxony, one of the leading Protestant princes, deserted the league and went over to the cause of the Emperor. The result was that the Protestant League was soon broken up.

267. *When and what was the triumph of Protestantism?*

The Emperor Charles V. becoming thoroughly tyrannical, his course excited the animosity as well of the Catholic as of the Protestant princes of Germany. He was compelled to sign a treaty at Passau (1552) by which the free exercise of their religion was secured to the Protestants. Three years later (1555), the principles of mutual toleration were formally sanctioned by the Diet of Augsburg.

268. *What were the most important features of the Protestant church?*

(1) Abolition of monastic orders and the celibacy of the clergy.
(2) Divine service in the language of the country.
(3) Distribution of the Bible to all.

269. *Who was the first of the Tudor line of English sovereigns?*

Henry VII., who, dying in 1509, left as heir to the throne a son, who is known to history as Henry VIII.

270. *Who was Cardinal Wolsey?*

He was the most notable figure in political affairs during the first twenty years of the reign of Henry VIII.

He was the son of a butcher; but displaying while young great quickness and intelligence, he received a learned education with a view to his entering the Church. His first employment at court was in the humble office of chaplain; but becoming acquainted with the young monarch, he soon grew to be a great favorite. He was made Archbishop of York, then High Chancellor of England, and finally became Henry's sole minister. He was finally stripped of all his places of power and wealth, and sinking under grief and mortification, he died in 1530.

271. *Why was Henry VIII. called Defender of the Faith?*

He wrote a book against the Lutheran doctrines. The Pope was so well pleased with the production that he gave the English king this title.

272. *Who were the six successive wives of Henry VIII.?*

Katharine of Aragon, Anne Boleyn, Jane Seymour, Ann of Cleves, Catharine Howard, and Catharine Parr.

273. *What was the fate of his respective wives?*

Katharine of Aragon and Ann of Cleves were divorced; Anne Boleyn and Catharine Howard were beheaded; Jane Seymour

died a year after marriage; and Catharine Parr, his last wife, survived the King.

274. *What is the verdict of historians on Henry VIII.?*

The common verdict is that he was a remorseless tyrant. In recent times a tendency to modify the vigor of this judgment has shown itself.

It is urged that an examination of contemporary history shows that for some of his arbitrary and seemingly cruel acts he had proper justification, and that many other measures which we must regard as reprehensible were forced upon him by the necessities of the difficult and perilous times in which he and England found themselves. In spite of his faults, his follies, and his crimes, his reign tended to the prosperity and glory of England.

275. *What may be said of the Netherlanders in the 16th century?*

At this period the Netherlanders had by industry and intelligence attained a high degree of prosperity. They were the boldest navigators and the most skillful manufacturers in Europe.

276. *Who was the Prince of Orange?*

William of Nassau, Prince of Orange, known in history as William the Silent, was a Protestant, and took up the cause of the people against the bigoted Philip II. of Spain, who had instituted the terrible Inquisition.

277. *When was the rise of the Dutch Republic?*

After a severe struggle of thirty-seven years, the independence of the Dutch Republic was secured, though it was not till the Peace of Westphalia (1648) that this independence was acknowledged.

278. *Who were the Huguenots?*

The French Protestants were followers of John Calvin, whose teaching was a greater departure from the doctrines of the Roman Church than was that of Luther. They were known by the name of Huguenots.

The Huguenots were cruelly persecuted by Francis I., in whose reign they first came into notice, as they were also by his successor, Henry II., and by *his* successor, Francis II.

279. *In the religious wars of France who were the principal leaders of the Huguenots?*

The Prince of Conde, Admiral Coligny, and Henry (King of Navarre).

280. *What was the Massacre of St. Bartholomew?*

It was an attempt on the part of the Catholics to exterminate the French Protestants, on the night of August 23–24, 1572. The conspirators wore badges by which they might be recognized. The dreadful work began on the ringing of the bells, when all Paris was wrapped in slumber. The victims of the horrible slaughter on that fearful night were estimated at 10,000. Royal orders were then forwarded through the provinces for the renewal of the massacre, and 45,000 more victims met death in its most appalling forms. Coligny was one of the first victims, and Henry IV. only escaped by attending mass.

The Huguenots flew to arms, and war raged for two years. The Protestants were finally overcome.

281. *How were the religious disputes settled?*

They were terminated in 1598 by the celebrated *Edict of Nantes*, which re-established all the favors that had ever been granted to the Protestants by other princes.

282. *Who was Queen Elizabeth?*

Elizabeth of England, called the "Virgin Queen," was the daughter of Henry VIII. and Anne Boleyn.

283. *Who was Mary Queen of Scots?*

She was the great-granddaughter of Henry VII., in the female line as rightful heir to the crown of England. Her claims to the crown caused her to be imprisoned for eighteen years. The Catholics plotted in her favor, but she was beheaded in 1587.

284. *What was the Spanish invasion of England?*

The Catholic powers of Europe, especially Philip II. of Spain, determined to crush England. The *Invincible Armada*, the most formidable fleet ever seen up to that time, sailed up the English Channel to attack England. The English vessels were much smaller, but active and well-manned. The English, assisted by the Dutch, all commanded by Lord Howard, drove the Spanish Armada into the harbor of Calais for refuge (July, 1588). Here they were attacked by fire-ships. The Spanish commander, in attempting to return home by way of the north of Scotland, was overtaken by a dreadful storm, and only one-third of the proud

Invincible Armada returned to Spain. The triumph of Protestantism was complete.

285. *What may be said of the reign of Queen Elizabeth?*

The reign of Elizabeth lasted forty-five years. It was a brilliant period for England at home and abroad. Wealth increased rapidly. The upper classes began to wear fine clothes and jewels. Coaches came into use in London. Manufactures throve and commerce was greatly extended with other countries. Literature reached its golden age in the immortal works of Shakespeare. Hardy explorers carried the English flag to every part of the earth.

286. *Who were the Puritans.*

They were dissenters from the Church of England, and professed to establish a purer form of worship. They were bitterly persecuted in England, and many found refuge in America.

287. *Who were the great artists of the 16th century?*

Michael Angelo, an Italian sculptor, painter, and architect.
Raphael, an Italian painter of great distinction.
Titian, a Venetian portrait and landscape painter.
Albert Dürer, a German painter, engraver, and sculptor.
Holbein, next to Dürer the most distinguished of German artists.

288. *Who were the great writers of the 16th century?*

Edmund Spenser, one of England's greatest poets. Chief work, *Faerie Queene.*

William Shakespeare, the greatest creative genius that ever lived. His works are as "household words."

Sir Philip Sidney, a courtier of Queen Elizabeth. Chief works, *The Arcadia,* and the *Defense of Poesie.*

Sir Walter Raleigh, also a courtier, a soldier, and an adventurer. As a writer he is known for one celebrated work,—his *History of the World.*

Cervantes, a renowned Spanish writer. Chief work, *Don Quixote.*

Rabelais, a famous French satirist. Chief work, *Life of Gargantua and Pantagruel.*

Montaigne, the most lovable of French skeptics. Chief work, his *Essays.*

Ariosto, an Italian poet, whose great work was *Orlando Furioso*.

Tasso, an Italian poet. Chief work, *Jerusalem Delivered*.

Camoens, the only Portuguese poet of European reputation. Chief work, the *Lusiad*.

289. *Who were the great Philosophers and Scientists of the 16th century?*

Copernicus, a celebrated German astronomer. He disproved the Ptolemaic theory of the universe.

Galileo, a celebrated Italian astronomer. He invented the telescope.

Tycho-Brahe, an astronomer of Copenhagen.

290. *What was the action of the Long Parliament?*

This was so called because it sat thirteen years. In 1640 the Long Parliament resolved to put a permanent check on royal authority. A bill was passed enacting that Parliament should be convened at least once every three years. Another bill declared that Parliament could not be dissolved without its own consent.

291. *Give data of the civil war in England in time of Charles I.*

Charles I. attempted to overawe Parliament by demanding five of its most obnoxious members. They were not given up. The clergy and the nobility sided with the king; the tradesmen and country people with a few of the nobility sided with Parliament. Oliver Cromwell was the leader of the Parliamentary party. For five years hostilities lasted, the greatest battles being at Marston Moor and Naseby, in both of which the royalists were defeated. The king, forced to surrender, was declared guilty of treason by a high court organized for the purpose, and beheaded, Jan. 30th, 1649.

292. *Who ruled England after the execution of Charles I.?*

Oliver Cromwell. He turned Parliament out of doors with a troop of soldiers. He became *Lord Protector of the commonwealth,* with absolute power. He subdued Ireland and awed the ambitious Catholic powers.

293. *What was the Restoration?*

The return of Charles II., and his restoration to kingly powers (1660).

294. *What was the character of Charles II. ?*

He proved one of the most dissolute kings of any age, and the people were not slow to copy his manners. The country prospered, however, and he avoided any conflict with the people.

295. *What was the character of James II.?*

He was a thorough tyrant and a devoted Catholic, and soon became odious to the people. He abdicated the throne of England (1688).

296. *What was the "Glorious Revolution of 1688"?*

The passage of the Bill of Rights (1688), by which was secured the liberties of the English nation against any future arbitrary acts. By the Bill of Rights the British Constitution became, in many important points, fixed and determined. This act secured by guaranties all the old English liberties which the Stuarts had violated. It laid the sure basis of the stability and the prosperity of England. William Prince of Orange, and Mary his wife, were crowned as joint sovereigns.

297. *What was the Thirty Years' War ?*

The Thirty Years' War began about 1618, and was terminated by the Treaty of Westphalia in 1648. This war had Germany for its center, and it was, properly speaking, a contest between the Catholic and Protestant princes of that country; but eventually most of the nations of Europe were drawn into it.

298. *What was the cause of the war ?*

The direct cause of the war was the persecution of Protestants by Ferdinand, King of Bohemia. Ferdinand became emperor in 1619. The Bohemians revolted and chose Frederick, elector of Palatine, a Protestant, as their king.

299. *What was the result of the war ?*

Frederick was beaten, and lost not only Bohemia but his own dominions. Ferdinand now determined to crush all the Protestant states. But Gustavus Adolphus, aided by Cardinal Richelieu of France, led the Protestant cause, and was everywhere successful. Peace was finally concluded, 1648, by which the Protestants gained most they contended for.

300. *What was the nature of the treaty of Westphalia?*

It was one of the most important treaties in the history of Europe. It established the religious independence of the Protestant states, and formally acknowledged the independence of Switzerland and Holland.

301. *What of the reign of Louis XIV.?*

Louis XIV. of France reigned seventy-two years (1643–1715). France became the greatest power in Europe. But the wars and court expenses of the "grand monarch" sapped the nation, and Louis lived long enough to see the affairs of France enveloped in gloom and ruined by disastrous defeat.

302. *Who was Cardinal Richelieu?*

He was prime minister of France from 1622 to 1642, and was the greatest statesman of his time. He greatly increased the power and territory of France. He crushed the Huguenots at home, but assisted the Protestants in Germany, in order to humble Austria. His policy proved bad in the end for France.

303. *What were some of the acts of Louis XIV.?*

He attempted to conquer the Netherlands, and formed an alliance with England for the purpose. The Dutch bravely resisted. England made peace with them, and they were assisted by Germany, Brandenburg, and Spain. This gigantic contest lasted four years. Louis revoked the Edict of Nantes, which granted freedom of worship to the Huguenots. Thousands of Protestants went into exile.

304. *What was The War of the Spanish Succession?*

It resulted from Louis XIV. supporting the claims of his grandson to the crown of Spain. As this would disturb the balance of power by making the Bourbons of France too powerful, England, Holland, and Germany united against France.

305. *What was the result of this war?*

At the great battle of Blenheim, 1704, Marlborough, the English commander, and Prince Eugene, of Austria, utterly defeated the French and Bavarians. The French lost ground everywhere, and peace ensued by the treaty of Utrecht, 1713.

306. *What was the progress of civilization during the 17th century?*

Civilization made great progress, but the comforts and conveniences of life were few compared with those of the present day. The masses were still ignorant and superstitious. The "Divine right of Kings" had reduced the people to a condition little better than slavery. They bore the burdens and fought the battles, while the ruling classes took the spoils and wore the honors. In France, especially, the peasantry were in such a wretched condition that in some cases they begged to be sold into slavery, so that their *responsibilities* might cease. The lands and personal effects of the French nobility and clergy were actually *exempt from taxation*. In England things were somewhat better. The English laborer lived on coarse fare, but had much personal freedom. He was ignorant and often brutal. Public schools were unknown. People traveled by stage-coaches, and highwaymen frequently robbed the passengers.

307. *Who were the great philosophers and scientists of the 17th century?*

Francis Bacon, the greatest of English philosophers; founder of the *Inductive* system of philosophy; great works: *Novum Organum, Advancement of Learning,* and *Essays.*

Descartes, a great French philosopher; had a great influence on the method of philosophizing.

Hobbes, a famous English philosopher; chief works, the *Leviathan* and the *Behemoth.*

Kepler, an illustrious German mathematician and astronomer; he discovered what are known as Kepler's "Three Laws," which laid the foundation of mathematical astronomy.

Harvey, lecturer at the College of Physicians, England; discovered the circulation of the blood (1620).

Spinoza, of Jewish birth—one of the great modern philosophers; his greatest work is *Ethica More Geometrica Domonstrata.*

Isaac Newton, professor of mathematics at Cambridge—discoverer of the law of universal gravitation; chief work, *Principia,* a Latin treatise on natural philosophy.

Liebnitz, a jurist, historian, mathematician, and metaphysician; founder of the eclectic system of German philosophy.

308. *Who were the great artists of the 17th century?*

Rubens, born in Westphalia, but son of a Dutch refugee from

Antwerp; most famous pieces, the *Descent from the Cross*, the *Last Judgment, Peace and War.*

Vandyck, pupil of Rubens; best historical picture, *The Crucifixion.*

Rembrandt, a native of Leyden, and one of the most original and able painters that ever lived.

Poussin, a great painter, born in Normandy; greatest works, *Death of Germanicus,* the *Taking of Jerusalem,* and the *Last Supper.*

Murillo, one of the most celebrated Spanish painters; his pictures are taken from humble life,—also religious pieces.

309. *Who were the great writers of the 17th century?*

Ben Jonson, soldier, actor, and poet-laureate, under James I., his earliest comedy, *Every man in his Humor.*

Calderon (De la Barca), a distinguished Spanish dramatist.

Corneille, a great French dramatist; chief works, the *Cid, Horace,* and *Cinna.*

John Milton, the greatest epic poet of modern times, author of *Paradise Lost* and *Paradise Regained.*

Samuel Butler, author of a mock-heroic poem called *Hudibras.*

Jeremy Taylor, an English bishop; chief works, *Liberty of Prophesying, Holy Living, Holy Dying.*

La Fontaine, a French poet and fabulist; chief works, his *Fables.*

Molière, a distinguished French dramatist and writer of comedies; chief works, *Le Bourgeois Gentilhomme, Le Misanthrope,* and *Tartufe.*

Pascal, an eminent French philosopher and scientist; chief works, *Provincial Letters* and *Pensées.*

Bossuet, one of the greatest pulpit orators of France.

John Bunyan, a tinker of Bedford; he wrote in prison the celebrated *Pilgrim's Progress.*

John Dryden, a great English poet—made poet-laureate by Charles II.; chief works, *Absalom and Achitophel,* the *Hind and Panther, Alexander's Feast.*

Boileau, a noted French poet; chief works, *Satires* and *Epistles,* and the *Lutrin.*

Fenelon, Archbishop of Cambray; best-known work, the romance of *Telemaque.*

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310. *Who was Peter the Great?*

He first gave Russia a name in history. Seeing the ignorance and barbarity of his subjects, he set about civilizing them. He went to Holland and studied ship-building, working as a day-laborer. He traveled over Europe, carefully studying the laws and customs of the people. He returned to Russia and at once began the reorganization of the internal affairs of his empire.

311. *Who was Charles XII. of Sweden?*

Charles XII. of Sweden ("the madman of the North") invaded Russia after having defeated the Poles and Danes. He attacked a force of Russians ten times his own army at Narva, in 1700 and totally defeated them. Charles haughtily refused to negotiate for peace. He penetrated into Russia and laid siege to Pultowa where he was totally defeated. He lost his entire army and fled to Turkey with 300 followers. He was finally killed by a cannon-ball while besieging a castle in Norway, 1718.

312. *Who was Frederick the Great?*

He was King of Prussia from 1740 to 1786, and placed her among the Great Powers of Europe. Taking advantage of the difficulties in which Maria Theresa of Austria was involved by rival powers who claimed portions of her dominions, he laid claim to Silesia, and annexed that province to Prussia (1742).

313. *What was the Seven Years' War?*

It began in 1756. Austria formed a secret treaty with France, Russia, Poland, Saxony and Sweden, for the partition of Prussia. England alone sided with Prussia. The war was a fierce one, but Frederick beat them all and retained all his territory. About 1,000,000 men fell in this war.

314. *When was the Partition of Poland?*

Under King John Sobieski the Poles compelled the Turks to raise the siege of Vienna (1683), and thus saved Central Europe from passing under the rule of the Moslem. But Poland rapidly declined and became a prey to internal dissensions and the rapacity of her neighbors. An infamous agreement was entered into between Austria, Prussia, and Russia by which the greater part of Poland was "*partitioned*" between these powers, 1772. A

second partition took place in 1792, and a third in 1795, wiped Poland from the list of nations. The unfortunate Poles made a gallant defense of their liberties, but in vain.

315. *Who was the Pretender?*

He was the son of James II., and called himself James III. He had pretensions to the throne of England and Scotland, for he did not acknowledge the union of the two kingdoms.

His supporters were called "Jacobites," from Jacobus, the Latin name for James. Louis XIV. had promised the Pretender aid in winning the British throne; but just then the French king died,—so that when in 1715 risings were made both in Scotland and England in the cause of the Pretender, and he himself came over from France to join in, he was easily defeated, and the attempt utterly failed.

316. *What were the four wars of the reign of George II.?*

The war with Spain; the war of the Austrian Succession; the war for the Young Pretender; the American war with France (French and Indian war).

317. *Who was Sir Robert Walpole?*

He was Prime Minister during nearly half the reign of George II.

He was a man of little learning, rough and boisterous in manners and in his life; but he retained his great power with a passionate grasp. Bribery was the secret of his long reign as Premier.

318. *Who was Sir William Pitt?*

William Pitt, known as the *Great Commoner*, was educated at Oxford, served in the army, then in Parliament, and finally giving himself up entirely to politics, he won for himself a leading place in the government of his country.

He directed all his genius to raising the glory of England both in America and in India; and it was to his clear head and admirable administrative faculties that Great Britain owed her formidable position in the politics of Europe in the middle of the 18th century.

319. *What were the chief events of the reign of George III.?*

The French and Indian War; the American Revolution; the British Conquest of India; and the long wars with Napoleon.

320. *What were the forerunners of the French Revolution?*

The court was usually influenced by intriguing women. The nobility and clergy were extravagant, haughty, and given to pleasure. The finances were in a terrible condition. Continuous

costly wars had sapped the life of the nation. The writings of Voltaire, Rousseau, and other freethinkers had caused thousands to awaken to a realization that something was radically wrong in the social fabric.

The nobility and clergy together owned nearly two-thirds of the entire landed property of France and were exempt from all taxes. Finally the complete independence of the United States, achieved with the assistance of French arms, contrasted painfully with the condition of the French people themselves. The people *began to think for themselves.*

321. *What was the action of the French National Assembly?*

In 1789 Louis XVI., advised by his prime minister Necker, a prudent and able man, called a meeting of the States General, or National Assembly. This body consisted of three divisions, the *Nobility*, the *Clergy*, and the *Third Estate*, or Commons. The latter outnumbered both the others and knew its power. On the refusal of the nobility and clergy to organize as *one* body, the Third Estate, or Commons, declared itself the National Assembly. The Duke of Orleans and others of the nobility and clergy joined the popular party. They resolved never to adjourn till they gave France a constitution.

All Paris was in a ferment. The National Assembly abolished all the odious feudal privileges and levied taxes equally on all classes.

322. *How did the people act?*

They grew enthusiastic; broke open gun shops and armed themselves. On a report that soldiers were about to turn the National Assembly out of doors, the mob stormed the Bastile, one of the most hateful of the French prisons, where men were condemned to rot without trial. The governor, De Launy, and his handful of Swiss guards, surrendered. He and some other officers were massacred and the Bastile razed to the ground (July 14, 1789). The *people* were supreme and the nobility began to *emigrate* hastily.

323. *What was the "Joyous Entry"?*

The king indiscreetly ordered fresh troops to Versailles, and at a banquet in the palace, some of the officers trampled under foot the tri-colored cockades of the Revolution and substituted white ones of the House of Bourbon. The mob of Paris attacked and forced the palace, and the royal family were only saved by Lafay-

ette at the head of the National Guard. The king and his family were taken in triumph to Paris as prisoners.

324. *What action was taken by foreign powers toward France?*

The powers of Europe became alarmed at the progress of the Revolution, Prussia and Austria declared war against France in 1792. Large armies crossed the Rhine and marched toward Paris. The allies were defeated and driven from France. The interference of foreign powers greatly incensed the extreme Republicans.

325. *Who were the leaders of the French Revolution?*

In the National Convention (assembly), the most radical leaders were DANTON, MARAT, and ROBESPIERRE. Robespierre, the most notorious figure of the Revolution, was the counsellor and secret leader of the Jacobin Clubs, which embraced the worst elements of Paris.

326. *What of the attack on the Tuileries?*

On the 10th of August, 1792, the Tuileries were attacked and the Swiss guard massacred. The king and family were removed to prison.

327. *What was the Massacre of September?*

The Jacobins insisted on the formation of a " Revolutionary Tribunal" which was appointed amid the protests of the Convention. Hundreds of persons were in prison and an awful massacre was begun September 2, 1792. Many were hacked to pieces without even the form of a trial. None of the accused received mercy at the hands of the court.

328. *What was the fate of the king?*

Louis was deposed and the Republic proclaimed September 20 (1792). The king was charged with conspiring with the allies and of having knowledge of their movements. He was pronounced guilty and condemned to death. The execution took place January 21, 1793.

329. *What party opposed the Jacobins?*

The only really powerful opposition to the Jacobin party were

the Girondists. They favored milder measures, but were over-whelmed and most of them guillotined.

330. *What was the "Reign of Terror"?*

It was inaugurated May 31, 1793. Marat was assassinated by a young woman named Charlotte Corday. Danton had a short time before been denounced by the Jacobins and executed. Robespierre remained undisputed leader of the Jacobins. He kept the guillotine busy till the executions for months averaged from 50 to 80 per day, and 1,285 from June 10th to July 17th, 1794.

Among the victims was the beautiful Marie Antoinette, queen of Louis XVI. The madman of the Revolution now made a new calendar and changed the names of the months and weeks. The Sabbath was abolished and the worship of Reason substituted for the Christian religion.

331. *What was the fate of Robespierre?*

The horrors of the Reign of Terror caused a reaction. Robespierre himself was arrested and lodged in prison, suffering from a horrible wound. He and his fellows were guillotined July 28, 1794, and the Reign of Terror ended.

332. *How and when was the French Revolution ended?*

At the death of Robespierre a new constitution went into effect, and the government was intrusted to a *Directory* of five men. The mob of Paris resisted, but NAPOLEON BONAPARTE, who commanded the artillery, swept the streets with grape shot and quelled the insurrection. The Revolution was ended; Napoleon began his wonderful career of almost continuous warfare for twenty years against most of the powers of Europe. The Directory continued from 1795 to the end of 1799.

333. *What were the chief events in the Wars of Napoleon?*

1796. Napoleon defeats the Austrians at the bridge of Lodi, May 10, and at Arcola, November 14.

1797. Beats the Austrians at Rivoli and captures Venice. By treaty of Campo Formio, Austria cedes much territory to France.

1798. Invades Egypt. Destroys the Turkish power at the battle of the Pyramids, July 21. The French fleet destroyed by the English fleet under Admiral Nelson, at the battle of the Nile, August 1.

1799. The allies defeated in Switzerland. Siege of Acre. Napoleon defeats the Turks at Mount Tabor and Aboukir. Chosen First Consul, December 24.

1800. Defeats the Austrians at Marengo, Italy, two to three times his own number, June 14. The French Gen. Moreau defeats the Austrians at Hohenlinden, December 3. The Austrians lose 100 pieces of artillery and 14,000 men.

1801. Forms a mercantile league with Prussia, Sweden, Russia, and Denmark against England. English destroy the Danish fleet in the harbor of Copenhagen, April 2. Dissolution of the confederacy.

1802. Peace with England. Napoleon causes a thorough revision and codification of the French laws. Projects great internal improvements and improves the finances. Declared First Consul for life.

1804. Napoleon crowned Emperor by the Pope. The Third Coalition, consisting of England, Austria, Russia, Prussia, and Sweden.

1805. Napoleon defeats the Austrians and Russians at Austerlitz, December 2, inflicting a loss of 30,000 men. Austria compelled to give up Tyrol and her Italian possessions. Nelson destroyed the combined French and Spanish fleets off Trafalgar, October 21.

1806. Prussia crushed at Jena and Auerstadt, October 14. Prussian loss, 40,000 men, killed, wounded, and prisoners. Joseph Bonaparte made King of Naples, Louis Bonaparte King of Holland.

1807. Drawn battle at Eylau, February 8. Russian loss, 25,000 killed and wounded; French loss, 30,000 killed and wounded. Russians defeated at the bloody battle of Friedland, June 14. Peace of Tilsit, favorable to Napoleon. New Kingdom of Westphalia, on the Rhine, with Jerome Bonaparte as king. Milan Decree against English commerce.

1808. The French lose and gain ground in Spain. Joseph Bonaparte declared King of Spain, June 6.

1809. Battle of Aspern and Esseling; French defeat. Battle of Wagram, July 5 and 6; Austrians defeated. Capture of Vienna. Austria deprived of more territory.

1810–1811. Continuous war between French and English in Spain. Zenith of Napoleon's power.

1812. Invasion of Russia by the "Grand Army," numbering 500,000 men. Battle of Borodino; Russians defeated with loss of 47,000 men, killed, wounded, and prisoners; French loss, 50,000. Burning of Moscow. Horrors of the winter retreat. Total loss of the Grand Army, 450,000.

1813. Napoleon defeats the Prussians and Russians at Lutzen and Bautzen, May. Is defeated by the allied Austrians, Prussians, and Russians at Leipsic, October 16-19. French loss, 60,000; loss of allies, 40,000.

1814. Occupation of Paris by the allies. Abdication of Napoleon and his retirement to the island of Elba, with the rank of Emperor.

1815. Napoleon again assumes the government of France—"The 100 days." Defeated at Waterloo, June 18. Exiled to St. Helena. Died 1821.

334. *Who were the great philosophers and scientists of the 18th century?*

Swedenborg, Benjamin Franklin, Linnæus, D'Alembert, William and John Hunter, Adam Smith, Kant, Priestley, Galvani, William Herschel, Lavoisier, Bentham, and Laplace.

335. *Who were the great writers of the 18th century?*

Jonathan Swift, Addison, Alexander Pope, Richardson, Montesquieu, Voltaire, Buffon, Fielding, Samuel Johnson, David Hume, Rousseau, Sterne, Oliver Goldsmith, Lessing, Edmund Burke, Edward Gibbon, Robert Burns, and Schiller.

336. *Who were the great artists of the 18th century?*

Handel, Sir Joshua Reynolds, Thomas Gainsborough, Haydn, Benjamin West, Mozart, and Canova.

337. *Who were the great inventors, and what the inventions of the 18th century?*

James Brinley, native of England; founder of canal navigation.

Hargreaves, born in England, invented the carding machine, and the spinning-jenny (1795).

Josiah Wedgwood, an Englishman; inventor of "Queen's ware."

Sir Richard Arkwright, English, invented the spinning-frame.

James Watt, English, invented the double-acting condensing steam-engine, and applied it to machinery.

Jacquard, French, invented the loom for figured weaving.

Crompton, invented *the mule,* a machine that greatly facilitated the spinning of yarn.

Robert Fulton, American, constructed the first large steam-vessel, which made its trial trip on the Hudson in the year 1807.

338. *What were some of the minor inventions and industries of the 18th century?*

Piano-forte: invented by an organist of Dresden in 1717.

Chaoutchouc, or **India-rubber:** was taken to Europe from South America in 1730.

Stereotyping: by William Ged of Edinburgh

Chronometer: by John Harrison (1736–1742).

Umbrellas: in 1778 Joseph Hanway introduced one into England, probably from Spain.

Vaccination: by Jenner, 1796.

Hydraulic Press: invented by Bramah, an Englishman, in 1786.

Gas-lights: used in some factories in England (1792–1798). Gas was not used for street-lighting until the beginning of the 19th century.

Cotton-gin: by Eli Whitney, an American, in 1793.

Lithography: invented in Germany (1796).

339. *Make brief mention of French history from the exile of Napoleon to the Franco-Prussian war.*

After the exile of Napoleon the Bourbons were restored to the throne of France. The Bourbons continued to rule until a revolution drove them from the throne, 1830. The cause was a re-

newal of the old Bourbon *absolutism*. Louis Phillippe was elected king. He reigned until another revolution took place, in 1848, when a republic was established for a time. Louis Napoleon, a nephew of the great Napoleon, illegally seized the government, and was declared Emperor, with the title Napoleon III., December 2, 1852. He reigned until 1870, until a republic was proclaimed at the close of the Franco-Prussian war.

340. *Mention the important events of the first quarter of the 19th century.*

A war began between England and the United States in 1812 and lasted till 1815. The results were favorable to the United States.* The South American Republics, the Empire of Brazil, the Central American States, and Mexico became independent between the years 1810 and 1821. Greece, with the aid of European powers, established her independence, 1821.

341. *What reforms were brought about in Great Britain?*

The old manner of electing members of Parliament had grown obsolete and afforded many opportunities for corruption. Boroughs existed which had scarcely a dozen voters. These sittings were of course held by wealthy men and were often corruptly bought. *The Reform Bill* of 1832 abolished all these "rotten boroughs," and greatly increased the number of voters by allowing all who owned a certain amount of property or who paid a certain *rent* to vote. The corn laws, levying a duty on grain and cattle, were repealed in 1846. Another reform bill in 1867 still further extended the franchise. In 1869 the Irish Church was *disestablished, i. e.,* declared to be no longer the *State* Church of Ireland as it still is in England.

342. *What rebellion in India in 1857?*

A Sepoy rebellion broke out in India in 1857, led by Nana Sahib. The Sepoys were native soldiers in the British service. They rebelled because they supposed their cartridges were greased with lard, an abomination to them. The rebellion spread among the natives and was only suppressed after awful atrocities had

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* Since United States History is usually studied in grades below the High School, it is not taken up in this work.

been committed. The chief events were the *massacre of Cawnpore* and the siege of Lucknow.

343. *What troubles existed in Hungary in 1848 ?*

Internal troubles in Hungary in 1848 finally led to civil war. Austria and Russia interfered and the Hungarians were overwhelmed. The patriot leaders, Kossuth and others, went to the United States in exile.

344. *What was the Crimean War ?*

The Crimean War took place in 1854–55, because the Czar Nicholas seized some Turkish territory. France, England, and Sardinia aided Turkey, lest Russia should destroy the *balance of power* in Europe by the acquisition of too much territory. The principal events were the battles of Alma and Inkerman and the siege of Sebastopol. Russia was forced to abandon her designs.

345. *What was the Unification of Italy ?*

France, aided by Sardinia, took a large portion of the Austrian territory in Italy, after a short, sharp war, the principal battles of which were Magenta, June 4, 1859, and Solferino, June 24. Part of Lombardy was ceded to the King of Sardinia, who in turn ceded Nice to France. Garibaldi in 1860 inaugurated a revolution which finally drove out the King of Naples and Sicily, which territories were annexed to Sardinia. This last State now became the Kingdom of Italy. The unification was completed in 1870, when the Papal territories were added to Italy.

346. *What was the Unification of Germany ?*

A quarrel took place in 1866 between Prussia and Austria over the disposition of Schleswig-Holstein which they had just taken from Denmark. In the great battle of Sadowa the Austrians were totally defeated, with terrible loss. The North German Confederation was then formed, with Prussia as the leading State, instead of Austria.

347. *What was the Franco-Prussian War ?*

France and Prussia had long been jealous of each other. Leopold, of Hohenzollern, a relative of the King of Prussia (1870), became a candidate for the Spanish throne. France objected and

both sides began operations at once,—July, 1870. This terrific contest was soon over. The French were beaten everywhere, and finally Napoleon surrendered to King William, at Sedan, September 2. Paris endured the horrors of a prolonged siege, but was forced to surrender, January 28, 1871. A *French Republic* was established; France had to cede Alsace and part of Lorraine, which had been taken from Germany by Louis XIV., and pay an indemnity of 5,000,000,000 francs.

348. *What was the war between Russia and Turkey (1878)?*

It ended in the defeat of the Turks, after a bloody struggle. At Plevna the Turks won a decided victory. Roumania and Servia became independent and Bulgaria semi-independent.

349. *What of the late agitation in Ireland?*

The Irish Land League kept up a continued agitation in Ireland for the reduction of rents and a redress of Irish grievances. These grievances were so real and pressing that Parliament finally passed the *Irish Land Bill* late in the year 1881.

350. *What have been the late warlike troubles of Great Britain?*

A war with the Dutch Boers in South Africa was ended in 1881 by England's granting most of the concessions asked by the Boers. In 1879 a war had been waged against the Zulus of South Africa; it ended in their submission.

351. *Mention the great philosophers and scientists of the 19th century.*

Alexander von Humboldt, a German naturalist; chief work, his *Kosmos.*
Cuvier, a Swiss; principal works, *The Animal Kingdom and Discourses on the Revolutions of the Surface of the Globe.*
Hegel, a German philosopher.
Sir Humphrey Davy, a celebrated chemist and natural philosopher; invented the safety-lamp for miners.
Arago, a distinguished French *savant.*
Sir William Hamilton, a Scotch metaphysician and logician.
Faraday, an eminent physical philosopher.
Comte, a famous French philosopher, and author of the Positive Philosophy.
Liebig, a great German chemist.
John Stuart Mill, an eminent English philosopher, author of *Political Economy, Logic,* etc.
Sir David Brewster, a distinguished Scottish scientist; edited the *Edinburgh Encyclopedia;* wrote *Letters on Natural Magic* and a *Life of Newton.*
Leverrier, a great French astronomer; discovered the planet *Neptune.*

John Tyndall, a natural philosopher; author of *Heat Considered as a Mode of Motion, Glaciers of the Alps,* etc.

Louis J. R. Agassiz, an eminent naturalist; leading works, *Poissons Fossiles, Contributions to the Natural History of the United States,* and *Methods of Study in Natural History.*

352. *Mention the great writers of the 19th century.*

Goethe, one of the most glorious names of Germany; chief works, *Werther, Wilhelm Meister,* and *Faust.*

Richter, a German author and humorist; principal works, *Titan, Hesperus,* and *Levana on Education.*

William Wordsworth, an English poet; chief works, *The Excursion* and *The White Doe of Rylstone.*

Sir Walter Scott, poet and novelist; chief poems, *Lady of the Lake* and *Lay of the Last Minstrel.*

Samuel Taylor Coleridge, an English poet; chief works, *The Ancient Mariner* and *Christabel.*

Thomas Campbell, a Scottish poet; chief works, *Pleasures of Hope, The Battle of the Baltic,* and *Ye Mariners of England.*

Beranger, a noted lyric poet of France; he is called the Burns of France.

Jacob and **William Grimm,** brothers; greatest works, *Teutonic Grammar* and *German Dictionary,* also *Household Tales.*

Francois Pierre Guillaume Guizot, a French statesman and historian, author of a " *History of Civilization in Europe,*" etc.

Byron, an English poet; chief work, *Childe Harold's Pilgrimage.*

Thomas Carlyle, one of the greatest of modern English writers; greatest works, the *French Revolution, Life of Frederick the Great, Life of Cromwell, Sartor Resartus,* etc.

Prescott, an eminent American historian; chief works, *Ferdinand and Isabella, Conquest of Mexico,* etc.

Thiers, a French historian and statesman, author of *The French Revolution* and *The Consulate and the Empire.*

Pushkin, the greatest of Russian poets.

Macaulay, the finest historian of the day ; chief work, *History of England.*

Victor Hugo, a French poet, dramatist, novelist, and politician; best known novels, *Notre Dame, Les Misérables,* and *Ninety-three.*

Ralph Waldo Emerson, the "Sage of Concord,"—the most subtle and original thinker of America; leading works, *Essays, Representative Men,* etc.

Hawthorne, an American novelist, author of *The Scarlet Letter, Twice-Told Tales,* etc.

Alfred Tennyson, Poet Laureate of England; leading works, *The Princess, In Memoriam, Idyls of the King,* etc.

Thackeray, the profoundest of English novelists; leading works, *Vanity Fair, Pendennis, The Newcomes,* etc.

Charles Dickens, the most popular of English novelists,—the Shakespeare of the 19th century.

353. *Mention some of the great artists of the 19th century.*

Thorwaldsen, a Danish sculptor.

Beethoven, a great German musician; chief works, *The Mount of Olives* and *Fidelio.*

Weber, a distinguished musician of the German school; greatest work, *Der Freischütz.*

Turner, one of the best landscape painters of the English school.

Horace Vernet, one of the greatest of modern French painters.

Rossini, a great Italian musical composer; most celebrated operas, *William Tell* and *The Barber of Seville.*

Meyerbeer, a renowned German musical composer; greatest operas, *Robert le Diable, The Huguenots, The Prophet,* and *L'Africaine.*

Donizetti, a composer of Italian operas; best known works, *Lucrezia Borgia* and *Lucia di Lammermoor.*

Sir Edwin Landseer, famous for his paintings of animals.

Wilhelm Kaulbach, the most illustrious modern German painter, his masterpieces being the *Battle of the Huns* and the *Destruction of Jerusalem.*

Mendelssohn, born at Hamburg; chief works, his music for the *Midsummer Night's Dream,* and his sublime oratorios *St. Paul* and *Elijah.*

Verdi, an Italian composer; best known operas, *Il Trovatore* and *La Traviata.*

Gustave Dore, a French artist; well known for his illustrations of the works of Dante, and of *Don Quixote,* and the *Wandering Jew.*

354. *Mention some of the great inventors of the 19th century.*

Sir Isambard Brunel, a distinguished engineer; greatest work, the *Thames Tunnel.*

George Stephenson, the great railway engineer; inventor of the Locomotive Engine. His son Robert is distinguished as the engineer of the Tubular Bridge over the Menai Strait.

Daguerre, inventor of the Daguerreotype.

Prof. S. F. B. Morse; his world-wide fame is based on his invention of the Electric Telegraph.

Elias Howe, inventor of the Sewing Machine.

Ross Winans, inventor of the Railroad Passenger Car.

Charles Goodyear, inventor of Vulcanized Rubber.

Cyrus H. McCormick, inventor of the Harvesting Machine.

Prof. Graham Bell, inventor of the Telephone.

Thomas A. Edison, inventor of the Electric Light.

ENGLISH LITERATURE.

1. *What is English Literature?*

Literature is thought expressed in writing. English literature
is the literature of the English language wherever produced; but
it is sometimes divided, for convenience, into English literature
proper—the literature produced in England, and American litera-
ture—the literature produced in America.

2. *What are the two forms of literature?*

Literature exists in two forms,—poetry and prose.

3. *What is Poetry?*

Poetry is imaginative composition in metrical form. It is of
eight kinds,—Epic, Dramatic, Narrative and Descriptive, Lyric,
Didactic, Pastoral, Elegiac, and Humorous.

4. *Define the eight kinds.*

An Epic poem is a long poetic recital of some great event; as
Homer's Iliad, Milton's Paradise Lost.

Dramatic poetry is poetry in the form of dialogue. It is of
two kinds,—tragedies and comedies; as, Hamlet (tragedy), Mer-
chant of Venice (comedy).

A Narrative poem is a tale in verse. A Descriptive poem is
one that describes something. Narration and description are
generally combined; as, Chaucer's Canterbury Tales, Scott's Lady
of the Lake.

Lyric poetry is poetry suitable for music. It includes Psalms,
Hymns, Songs, Odes, and Sonnets; or, Shelley's Skylark, Words-
worth's Ode to Duty, Moore's Last Rose of Summer.

Didactic poetry is poetry designed chiefly to instruct; as, Pope's Essay on Man, Wordsworth's Excursion, Bryant's Thanatopsis.

Pastoral poetry is poetry descriptive of country life; as, Whittier's Snow-Bound, Tennyson's Enoch Arden, Taylor's Lars.

Elegiac poetry is poetry commemorative of the dead; as, Gray's Elegy Written in a Country Churchyard, Tennyson's In Memoriam.

Humorous poetry is poetry of an amusing character; as, Cowper's John Gilpin, Saxe's Proud Miss McBride.

5. *Define Prose.*

Prose is composition without metre or rhyme. It is of nine kinds,—History, Biography, Novels, Travels, Letters, Reviews, Essays, Treatises, and Discourses.

6. *Define the nine kinds.*

History is a record of past events; as, Hume's History of England, Bancroft's History of the United States.

A Biography is an account of the life of an individual; as, Irving's Life of Washington.

A Novel is a fictitious story. Among the best examples are the novels of Scott, Thackeray, and Dickens.

A Book of Travels is a record of the experiences and observations of a traveler; as, Bayard Taylor's Views Afoot.

A Letter is a composition addressed to a particular person. Letters are generally included in biography; as, Life and Letters of Lord Byron.

A Review is a long article founded on some literary work. Among the best reviews are those of Macaulay, Lowell, and Whipple.

An Essay is a brief and somewhat informal composition on any subject. Among the best essays are those of Lord Bacon, Addison, and Lamb.

A Treatise is a composition setting forth in a systematic manner the principles of some science or art; as, Haven's Mental Science, Brook's Geometry.

A Discourse is a composition intended to be read aloud or spoken by the writer. Discourses are of five kinds,—Orations, Addresses, Sermons, Lectures, and Speeches.

7. *When was the origin of English literature?*

English literature may be said to have begun with Chaucer, about the middle of the fourteenth century.

There were works that were written earlier than that, but they are in a language so different from modern English that they can not be read without a glossary.

8. *What are the nine periods of English Literature?*

Period   I. The Age of Chaucer, 1350–1400.
Period   II. The Age of Caxton, 1400–1550. —
Period   III. The Elizabethan Age, 1550–1625.
Period   IV. The Age of Milton, 1625–1660.
Period   V. The Age of the Restoration, 1660–1700.
Period   VI. The Age of Queen Anne, 1700–1750.
Period   VII. The Age of Johnson, 1750–1800.
Period   VIII. The Age of Scott, 1800–1830.
Period   IX. The Victorian Age, 1830–1886.

9. *What may be said of the Age of Chaucer (1350–1400)?*

This age is memorable in history on account of the military glories of Edward III. and his heroic son, the Black Prince; by which the Saxon and Norman elements of the people were united, a national sentiment established, and the supremacy of England secured.

It was also a period of religious agitation, of awakening thought, and of vigorous protest against the vices and tyranny of the higher orders of the clergy. At this time were sown by Wickliff and others the seeds that produced, more than a century later, the English Reformation under Henry VIII.

The chief literary representative of this age is our first great poet GEOFFREY CHAUCER (1328–1400). The contemporary authors are JOHN WICKLIFF (1324–1384), a learned preacher known as "The Morning Star of the Reformation," author of the first English translation of the Bible. WILLIAM LANGLAND (1332–1400), author of a powerful allegorical poem entitled *Piers Plowman*. JOHN GOWER (1320–1408), author of a poem entitled *Confessio Amantis*. SIR JOHN MANDEVILLE (1300–1372), author of a book of travels.

10. *What was the character of the Age of Caxton (1400–1550).*

This was the age of turmoil, and it gave rise to no great authors.

It is celebrated in history on account of four great events:
(1) The invention of printing, and its introduction into England by Caxton;
(2) The discovery of America;
(3) The Wars of the Roses;
(4) The Protestant Reformation in England under Henry VIII.

11. Name the authors of this age.

WILLIAM CAXTON (1412–1492), the first English printer. The first book printed in England was *The Game and Play of Chess.*

JOHN SKELTON (1460–1529). A satirical poet, first " Poet Laureate," tutor to the Duke of York, afterwards Henry VIII.

SIR THOMAS WYATT (1503–1542). A statesman and lyric poet of the reign of Henry VIII.

HENRY HOWARD, Earl of Surrey (1516–1547). A writer of sonnets and songs, and first writer of blank verse.

SIR THOMAS MOORE (1480–1535). Chancellor to Henry VIII., and author of *Utopia,* a prose romance.

TYNDALE (1480–1536) and COVERDALE (1487–1568), translators of the Bible.

12. Describe the Third Period, or Elizabethan Age (1550–1625).

This is the most glorious era of English literature. No other age presents such a splendid array of great names, such originality, such creative energy ; and no other has added so many grand ideas to the mental treasures of the race.

Within a period of eleven years (1553–1564) she produced three writers— Spenser, Shakespeare, and Bacon—either of whom would have made any age illustrious; besides many others, who, had they lived in any other period, would have stood in the first rank of authors.

13. What were some of the glories of this age?

Among the chief glories of the age were the rise and marvelous development of the English drama, and the translation of the Bible (our present version) under King James, in 1611.

14. Name the chief works of Spenser.

The Faerie Queen, a long allegory, setting forth the excellence of holiness, temperance, chastity, justice, courtesy, and friendship, under the guise of knights. Among the best of his other poems are his Epithalamion, or marriage song; Hymns of Love, Beauty, Heavenly Love, and Heavenly Beauty, and his exquisite Sonnets.

15. Name the greatest works of Shakespeare.

His greatest works are his dramas, thirty-seven in number.

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Among the best of his tragedies are Hamlet, Macbeth, Othello, and King Lear; among the best comedies, The Merchant of Venice, As You Like It, and Midsummer Night's Dream; among the best historical plays, Julius Cæsar, King Henry IV., King Henry V., and King Richard III.

16. *Name some works of Bacon.*

His most profound work is *Novum Organum* (The New Organ), but his most popular one is his Essays.

17. *Mention other non-dramatic poets of the Elizabethan Age.*

THOMAS SACKVILLE (1536–1608), Earl of Dorset, author of Mirror for Magistrates.

SAMUEL DANIEL (1562–1619), known as " well-languaged Daniel," author of Mrs. Cophilus, and History of the Wars of the Roses.

MICHAEL DRAYTON (1563–1631), author of Polyolbion and many other poems.

GEORGE HERBERT (1593–1632), known as "Holy George Herbert," author of The Temple, and The Country Parson.

18. *Mention other dramatic poets of the Elizabethan Age.*

CHRISTOPHER MARLOWE (1564–1593), the greatest dramatist before Shakespeare, author of Tamburlane and Faustus.

BEN JOHNSON (1574–1637), second to Shakespeare only, author of Every Man in his Humor, Volpone, or the Fox, Sejanius, etc.

BEAUMONT and FLETCHER, very popular in their day, wrote Two Noble Kinsmen, Rule a Wife and Have a Wife, Faithful Shepherdess, and many other works.

PHILIP MASSINGER (1584–1640), author of Duke of Milan, Fatal Dowry, New Way to Pay Old Debts, etc.

WEBSTER, FORD, CHAPMAN, SHIRLEY, and several others, were also distinguished dramatists of the second class.

19. *Mention other prose writers of the Elizabethan Age.*

SIR PHILIP SIDNEY (1554–1586), one of the most chivalrous gentlemen and accomplished writers of this age, author or Arcadia, a prose romance; Defense of Poesy, and some beautiful Sonnets.

SIR WALTER RALEIGH (1552–1618), courtier, soldier, adven-

turer, and writer, author of History of the World (written in prison), and several poems of much merit.

ROGER ASCHAM (1515–1569), tutor of Princess (afterward Queen) Elizabeth, and author of Toxophilus (archery), and The Schoolmaster.

RICHARD HOOKER (1583–1600), a learned and eloquent divine, author of Ecclesiastical Polity.

20. *Describe the Fourth Period, the Age of Milton (1625–1660).*

This was an age of fierce political and religious controversy. It was not favorable to authorship, hence but few works were produced, and these were mostly of a religious and controversial character.

21. *Who were the most celebrated authors of this age?*

JOHN MILTON (1608–1674), principal works: Paradise Lost, Paradise Regained, Samson Agonists, Comus, L'Allegro, Il Penseroso, Hymn to the Nativity. His best prose work is Areopagitica, a Plea for Unlicensed Printing.

JOHN BUNYAN (1628–1688), author of the greatest allegory in the world, Pilgrim's Progress.

22. *Mention other poets of the Age of Milton.*

EDMUND WALLER (1605–1687), author of Panegyric to My Lord Protector, and many short poems.

ABRAHAM COWLEY (1618–1667), author of The Mistress, Pindaric Odes, Davideis, etc.; also of some excellent Essays.

GEORGE WITHER (1588–1667), author of Shepherd's Hunting, Hymns and Songs of the Church, Abuses Stript and Whipt (a satire), etc.

ROBERT HERRICK (1591–1662), author of Cherry Ripe, Gather Rosebuds While Ye May, etc.

SIR JOHN SUCKLING (1608–1642), author of many charming short poems.

23. *Mention some other prose writers of this age.*

EDWARD HYDE (1608–1673), author of History of the Rebellion.
THOMAS HOBBES (1588–1679), author of The Leviathan.
SIR THOMAS BROWNE (1605–1682), author of Religio Medici.

IZAAK WALTON (1593–1683), author of The Complete Angler, and Walton's Lives.

THOMAS FULLER (1608–1661), author of Church History, The Holy and the Profane State, etc.

JEREMY TAYLOR (1613–1667), the great pulpit orator of the English Church, author of Holy Living, Holy Dying, etc.

DR. RICHARD BAXTER (1615–1691), author of Call to the Unconverted, etc.

24. *Describe the Fifth Period, or the Age of the Restoration (1660–1700).*

Corruption and licentiousness reigned in court and camp, and literature was debased and made to pander to the false tastes and lusts of the ruling class.

25. *Who was the only great genius that flourished in this age?*

JOHN DRYDEN (1631–1700). He wrote dramas, poems, and essays.

The best of his dramas is The Indian Emperor. His principal poems are Alexander's Feast, Absalom and Achitophel, The Hind and Panther, and a Translation of Virgil's Æneid.

26. *Mention other authors of this age?*

SAMUEL BUTLER (1632–1704), author of Hudibras.

JOHN LOCKE (1630–1704), author of Essays Concerning the Human Understanding.

SIR I.   (1642–1727), author of the Principia.

HON.   ᴜɪʟᴇ (1627–1691), one of the founders of the Royal Society.

JOHN EVELYN, F. R. S. (1620–1705), author of Sylva, etc.

27. *Describe the Age of Queen Anne (1700–1750).*

It was characterized by a sort of superficial refinement—a refinement not of morals and character, but of manners and language.

28. *Name the two chief authors of this Age.*

ALEXANDER POPE (1688–1744), whose principal works are the Essay on Criticism, Essay on Man, Rape of the Lock, The Dunciad, and a Translation of Homer.

JOSEPH ADDISON (1672–1719), whose principal works are the Tragedy of Cato, contributions to the *Tatler*, the *Spectator*, and the *Guardian*.

29. *Name some other authors of this age.*

DR. EDWARD YOUNG (1684–1765), author of Night Thoughts.

JAMES THOMSON (1700–1748), author of The Seasons, and The Castle of Indolence.

MATTHEW PRIOR (1694–1721), author of Solomon, Alma, and many fine lyrics.

JONATHAN SWIFT (1667–1745), author of Gulliver's Travels, The Tale of a Tub, etc.

DANIEL DEFOE (1661–1731), author of Robinson Crusoe.

JONATHAN EDWARDS, the great American metaphysician.

30. *Describe the Age of Johnson (1750–1800).*

During this age there was a higher moral tone, with a greater sincerity of manner. The authors may be divided into two classes: (1) The poets, represented by Goldsmith, Gray, Burns, and Cowper; (2) The prose writers, represented by Johnson and Burke.

31. *Mention the works of Goldsmith (1728–1774).*

His works may be divided into (1) Poetical, (2) Historical, and (3) Miscellaneous. His principal poems are The Traveller and The Deserted Village. Among the historical works are History of England, History of Rome, History of Greece, History of Animated Nature, etc. His miscellaneous works embrace The Vicar of Wakefield, She Stoops to Conquer, Letters from a Citizen of the World, etc.

32. *Name the works of Thomas Gray (1761–1771).*

His most celebrated poem is his Elegy Written in a Country Churchyard. The best of his other poems are Ode to Eton College, Ode to Adversity, The Bard, and Progress of Poesy.

33. *What are some of the poems of Robert Burns (1759–1796)?*

The words of Burns find a ready response in the universal heart, and his Highland Mary, Bonny Doon, Auld Lang Syne, have become household words wherever the English language is spoken.

Among the best of his poems, in addition to his songs, are The Cotter's Saturday Night, Tam O'Shanter, Twa Dogs, To a Mouse, To a Mountain Daisy, and Man was Made to Mourn.

34. *What may be said of Cowper (1731–1800) and his writings?*

Cowper is distinguished for his poems and his letters. Among the best of the former are, Lines on My Mother's Picture, The Task, his Hymns, and the humorous ballad of John Gilpin. His letters are among the finest specimens of epistolary style in the language.

35. *Mention other poets of this age.*

JAMES BEATTIE (1736–1803), author of The Minstrel.

THOMAS CHATTERTON (1752–1770), the boy poet, who deceived nearly all the scholars of his age by his imitations of Old English Poetry.

36. *Mention the writings of Johnson (1709–1784).*

His principal poems are London, The Valley of Human Wishes, and Irene. His chief prose works are his contributions to the Rambler, Rasselas, Lives of the Poets, and an English Dictionary.

37. *Name the works of Burke (1730–1797).*

His most celebrated works are—An Essay on the Sublime and Beautiful, Reflections on the French Revolution, Letters to a Noble Lord, and his great Speech on the Impeachment of Warren Hastings.

38. *Mention some other prose writers of this age.*

DAVID HUME (1711–1776), author of History of England.

EDWARD GIBBON (1737–1794), author of Decline and Fall of the Roman Empire.

TOBIAS GEORGE SMOLLETT (1721–1771), author of Roderick Random, Peregrine Pickle, and Humphrey Clinker.

LAWRENCE STERNE (1713–1768), author of Tristram Shandy and Sentimental Journey.

HANNAH MORE (1745–1833), author of The Inflexible Captive, The Shepherd of Salisbury Plain, Coelebs in Search of a Wife.

JUNIUS, supposed to be SIR PHILIP FRANCIS (1740–1818), author of the celebrated Letters of Junius.

RICHARD BRINSLEY SHERIDAN (1751–1816), author of School for Scandal.

HORACE WALPOLE (1717–1797), author of Castle of Otranto.

WILLIAM PALEY, D. D. (1743–1805), author of Natural Theology, etc.

JOHN and CHARLES WESLEY, founders of Methodism, eminent as scholars, preachers, and hymnists.

GEORGE WHITEFIELD (1714-1770), one of the most eloquent pulpit orators that ever lived.

Benjamin Franklin, Thomas Jefferson, Alexander Hamilton, and other American writers of the Period of the Revolution.

39. *Describe the Age of Scott (1800–1830).*

The Age of Scott is sometimes called the Age of Romantic Poetry. The reaction from the correct and artificial school of poetry, which had begun nearly a century earlier by Thomson, and carried on by Burns and Cowper, was now complete, and reached its culmination in the metrical romances of Scott and the impassioned outbursts of Byron and Shelley.

40. *Mention the Poets of the Age of Scott.*

LORD BYRON (1788-1824), the most splendid genius of the age. His finest poem is Childe Harold; his longest and most brilliant poem is Don Juan. Among the best of his other works are—The Dream, The Prisoner of Chillon, Mazeppa, The Bride of Abydos, Parisina, The Giaour, and the Siege of Corinth.

PERCY B. SHELLEY (1792-1822) as a lyric poet is unexcelled; author of The Skylark, The Sensitive Plant, and The Cloud.

THOMAS MORE (1779-1852), whose principal poetical works are Lalla Rookh, The Last Rose of Summer, Those Evening Bells, Come Ye Disconsolate, etc.

JOHN KEATS (1796-1820); principal poems, Endymion, Hyperion, The Eve of St. Agnes, Ode on a Grecian Urn, and Ode to a Nightingale.

THOMAS CAMPBELL (1777-1844); principal poems, Pleasures of Hope, Gertrude of Wyoming, Lochiel's Warning, O'Connor's Child, and Hohenlinden.

WILLIAM WORDSWORTH (1770-1850); principal work is The Excursion; but most readers prefer his shorter poems, such as Ode on Immortality, Ode to Duty, We are Seven, etc.

Some other poets of this age are:

MRS. FELICIA HEMANS (1794-1835), author of Vespers of Palermo, Graves of the Household, Casabianca, Landing of the Pilgrims, etc.

ROBERT POLLOK (1799-1827), author of The Course of Time.

THOMAS HOOD (1798-1845), wit and humorist, also author of The Death Bed, The Bridge of Sighs, Song of the Shirt.

JAMES SHERIDAN KNOWLES (1784-1862), author of Virginius, The Wife, The Hunchback, William Tell, etc.

American contemporaries: Robert Treat Paine, Joseph Rodman Drake, and Fitz-Greene Halleck.

41. *Mention the prominent prose writers of the Age of Scott.*

SIR WALTER SCOTT (1771–1832), whose works are of three classes: Poems, Novels, and Miscellaneous. His principal poems are The Lady of the Lake, The Lay of the Last Minstrel, and Marmion. His novels, known as the Waverley Novels, twenty-nine in number, are among the greatest creations of human genius. Among the best of them are—Waverley, Guy Mannering, Old Mortality, Heart of Mid-Lothian, Legend of Montrose, Ivanhoe, and Kenilworth. The most celebrated of his miscellaneous works are Tales of a Grandfather, and Letters on Demonology and Witchcraft.

ROBERT SOUTHEY (1774–1843), whose best works are his Life of Nelson, Life of Cowper, and Life of Wesley. His best poems are Thalaba and Curse of Kehama.

SAMUEL TAYLOR COLERIDGE (1772–1834), whose prose works are Aids to Reflection, The Friend, Lectures on Shakespeare, Table Talk, etc. His chief poems are Rime of the Ancient Mariner, and Christabel.

THOMAS DE QUINCY (1785–1859), whose chief works are his Confessions of an English Opium Eater, and his Essays.

CHARLES LAMB (1775–1834), who wrote under the name of "Elia."

42. *Describe the Victorian Age (1830–1885).*

More great works have been produced in history, in philosophy, in science, and above all in fiction, than in any other era of the world's history.

The authors may be divided into two classes:
(1) The POETS, represented by Tennyson, Mrs. Browning, Robert Browning, Jean Ingelow, Swinburne, and Morris.
(2) The PROSE WRITERS, represented by Macaulay, Dickens, Thackeray, Lord Lytton, George Eliot, Sir William Hamilton, Darwin, Carlyle, and Ruskin.

43. *Mention the great Poets of the Victorian Age.*

ALFRED TENNYSON (1810——), whose finest poems are: The May Queen, Locksley Hall, The Princess, In Memoriam, The Talking Oak, Maud, Enoch Arden, and Idyls of the King.

MRS. ELIZABETH BARRETT BROWNING (1807–1861), author of Lady Geraldine's Courtship, Casa Guidi Windows, Bertha in the Lane, Cowper's Grave, The Cry of the Children, A Child Asleep, etc.

ROBERT BROWNING (1812–), whose finest poems are Pippa Passes, A Blot on the Scutcheon, Colombe's Birthday, The Ring and the Book, How They Brought the Good News from Ghent to Aix, etc.

JEAN INGELOW (1830–), author of Songs of Seven, The Letter

L, Songs of the Night Watches, Songs with Preludes, Songs on the Voices of Birds, and High Tide on the Coast of Lincolnshire.

ALGERNON CHARLES SWINBURNE (1843–); principal poems, Atalanta in Calydon, Chastelard, A Song of Italy, and Bothwell.

WILLIAM MORRIS (1830–), principal works, The Life and Death of Jason, and The Earthly Paradise.

Other poets of this age are: Bryan Waller Proctor, Adelaide A. Proctor, Coventry Patmore, Gerald Massey, Charles Mackay, "Owen Meredith" (now Lord Lytton), Robert Buchanan, Sydney Dobell.

44. *Mention the prose writers of the Victorian Age.*

THOMAS BABINGTON MACAULAY (1800–1859); principal works are his Lays of Ancient Rome, Essays, and History of England. His ballads are Horatius at the Bridge, The Battle of Ivry, etc.

CHARLES DICKENS (1812–1870), one of the greatest novelists of all time. Among his best novels are Pickwick Papers, Nicholas Nickleby, David Copperfield, Dombey and Son, Our Mutual Friend, The Old Curiosity Shop, Great Expectations, and Christmas Stories.

WILLIAM MAKEPEACE THACKERAY (1811–1863), author of Vanity Fair, Pendennis, Henry Esmond, The Virginians, and The Newcomes; also author of two admirable courses of lectures on The Four Georges, and The English Humorists.

SIR EDWARD GEORGE BULWER-LYTTON (formerly BULWER) (1805–1873), whose principal works are Pelham, Eugene Aram, The Last Days of Pompeii, Rienzi, The Caxtons, and Kenelm Chillingly. He is also author of two excellent dramas, Richelieu and The Lady of Lyons.

MRS. MARIAN C. LEWES (GEORGE ELIOT) (1820–1884); principal works are Adam Bede, The Mill on the Floss, Romola, Felix Holt the Radical, Silas Marner, Middlemarch, and Daniel Deronda. She is also author of The Spanish Gypsy, and Jubal and other Poems.

SIR WILLIAM HAMILTON (1788–1856), whose principal works are Essays from the Edinburgh Review, his edition of Reid's Works, and his Lectures.

CHARLES DARWIN, F. R. S. (1809–1882); principal works, The Variation of Animals and Plants, The Origin of Species, The Descent of Man, and Expression in Man and Animals.

THOMAS CARLYLE (1795–1884), one of the most vigorous and original writers of the age. His greatest works are Sartor Resartus, Hero Worship, The French Revolution, Life of Frederick the Great, etc.

JOHN RUSKIN (1819–), the greatest art critic of his time. His most celebrated works are Modern Painters, Seven Lamps of Architecture, and Stones of Venice.

Some other prose writers of this age are: George Grote, Sir Archibald Alison, James Anthony Froude, Arthur Helps, Miss Agnes Strickland, Rt. Hon. Benjamin Disraeli, Anthony Trollope, Charles Reade, G. P. R. James, Charlotte Bronte, Wilkie Collins, Thomas Hughes, Capt. Mayne Reid, John Stuart Mill, Herbert Spencer, Sir David Brewster, Hugh Miller, Mrs. Mary Somerville, John Tyndall, Thomas H. Huxley, Max Müller, Rt. Hon. William E. Gladstone, Dean Stanley, Rev. C. H. Spurgeon, etc.

45. *When did American Literature begin?*

In 1640, the year in which the first book was printed in this country.

This was the *Bay Psalm Book.* Most of the books produced in America before this time may be regarded as English books, as they were not only printed in England, but were also intended mainly for English circulation.

46. *How is American Literature divided?*

It may be divided into three Periods:
  I. The Colonial Age, 1640–1760.
  II. The Revolutionary Age, 1760–1830.
  III. The American Age, 1830–1886.

47. *Describe the Colonial Age (1640–1760).*

This age was unfavorable to literary production. It was an age of fighting rather than writing. Most of the literature of this age is theological. This is owing to two causes: (1) That learning was mostly confined to the clergy; and (2) That the mingling of various sects, in a time of strong religious feeling, naturally provoked much theological discussion.

Its chief literary representatives are COTTON MATHER (1663–1728) and JONATHAN EDWARDS (1703–1758).

The most celebrated works of Mather are Magnalia Christi Americana, Memorable Providences, Relating to Witchcraft, and The Wonders of the Invisible World.

The greatest work of Edwards is An Inquiry into the Freedom of the Will.

48. *Mention some other authors of this age?*

JOHN ELIOT, "the apostle to the Indians," who translated the Bible into an Indian dialect.

MRS. ANN BRADSTREET, the first American poetess, author of The Four Elements.

REV. INCREASE MATHER, father of Cotton Mather, and author of Remarkable Providences.

49. *Describe the Revolutionary Age (1760–1830).*

In this age was fought, with tongue and pen and sword, the great battle of political independence. During all this period, the chief subjects of thought and discussion were the rights of man and the principles of government. As a consequence, the literature of the age, both in prose and poetry, is almost exclusively of a political and patriotic character.

The authors of this age may be divided into two classes :
I. The Poets, represented by Drake and Halleck.
II The Prose Writers, represented by Franklin, Jefferson, Hamilton, Dwight, and Audubon.

50. *Mention the Poets of the Revolutionary Age.*

JOSEPH RODMAN DRAKE (1795–1820), author of two celebrated poems, The American Flag, and The Culprit Fay.

FITZ-GREENE HALLECK (1795–1867), whose poems are few but of great excellence. His principal poem, Marco Bozzaris, is one of the very finest heroic odes in the English language.

Other poets of this age are : Philip Freneau, Judge Francis Hopkinson, author of a once celebrated humorous poem, The Battle of the Kegs ; Judge Joseph Hopkinson, author of Hail Columbia ; Robert Treat Paine, author of the poem Adams and Liberty ; Francis Scott Key, author of The Star-Spangled Banner.

51. *Mention some of the prose writers of the Revolutionry Age.*

BENJAMIN FRANKLIN (1706–1790), whose works consist of his Autobiography, his Essays, and his Correspondence. Some of his short pieces, such as The Whistle, The Grindstone, and the Dialogue with the Gout, have found their way into a large number of school readers ; and his wise sayings known as Poor Richard's Maxims are as familiar as the Proverbs of Solomon.

THOMAS JEFFERSON (1743–1826), author of Notes on Virginia, etc.; but his greatest work is the Declaration of Independence.

ALEXANDER HAMILTON (1757–1804), whose fame as a writer

rests chiefly upon his contributions to the *Federalist*, in which are expounded the principles of the Constitution.

DR. TIMOTHY DWIGHT (1752–1817), whose principal prose work is Theology Explained and Defended; best poetic works are Columbia, Greenfield Hill.

JOHN JAMES AUDUBON (1780–1851), whose greatest work is The Birds of America. He and his sons subsequently published a work entitled Quadrupeds of America.

Some other prose writers of this age are: John Adams, James Madison, Judge H. H. Brackenridge, Dr. David Ramsay, Washington Allston, William Wirt, Alexander Wilson, Judge Kent, Judge Story, Chief Justice Marshall.

52. *Describe the American Age (1830–1886).*

In this age our literature began to assume a national importance and to show signs of a distinct national life.

53. *Mention some of the poets of this age.*

WILLIAM CULLEN BRYANT (1794–1878), whose finest poems are: Thanatopsis, Death of the Flowers, Forest Hymn, The Evening Wind, Song of the Stars, The Planting of the Appletree, Waiting at the Gate, The Flood of Years.

HENRY WADSWORTH LONGFELLOW (1807——), whose most popular poems are: Evangeline, Tales of a Wayside Inn, Courtship of Miles Standish, The Building of the Ship, The Old Clock on the Stairs, The Bridge, The Builders, The Day is Done, The Hanging of the Crane, and Morituri Salutamus, etc.

JOHN GREENLEAF WHITTIER (1808–1882), whose most popular poems are: Maud Muller, Barbara Fritche, My Psalm, My Playmate, Snow-Bound, Among the Hills, A Tent on the Beach, Mabel Martin, and Centennial Hymn. His principal prose works are Old Portraits and Modern Sketches, and Literary Recreations.

JAMES RUSSELL LOWELL (1819–1867), whose best poems are: The Biglow Papers, The Present Crisis, Sir Launfal, A Glance Behind the Curtain, Under the Willow, Commemorative Ode, The First Snowfall, Longing, and The Changeling. His principal prose works are—Among My Books, and My Study Window.

OLIVER WENDELL HOLMES (1809——), one of the most witty, original, and brilliant writers of the present day. His lyrics are: Union and Liberty, Old Ironsides, Welcome to all Nations, etc.;

his humorous poems, The One-Horse Shay, My Aunt, etc. The best of his prose works is the series of papers contributed to the Atlantic Monthly, under the title of The Autocrat of the Breakfast Table. These were followed by The Professor at the Breakfast Table, Elsie Venner (a novel), The Guardian Angel (a novel), and The Poet at the Breakfast Table.

EDGAR ALLEN POE (1811-1849), author of several weird and powerful romances—among them The Fall of the House of Usher, The Gold Bug, and The Murders of the Rue Morgue—and a number of poems, the most remarkable of which are The Raven, and The Bells.

JOHN GODFREY SAXE (1816——), author of The Briefless Barrister, The Proud Miss MacBride, and his travesties on Orpheus and Eurydice, Pyramus and Thisbe, etc.

THOMAS BUCHANAN READ (1822-1872), whose most important poems are—The New Pastoral, The House by the Sea, The Wagoner of the Alleghenies, Drifting, and Sheridan's Ride.

BAYARD TAYLOR (1825——), whose principal poems are: Poems of Home and Travel, Poems of the Orient, Picture of St. John, The Poet's Journal, etc.; also the following novels: Hannah Thurston, The Story of Kennett, John Godfrey's Fortunes, etc.

MISS ALICE CARY (1820-1871), whose poems, together with her sister Phœbe's, fill several volumes. Among the best of her separate poems are—Thanksgiving, Pictures of Memory, The Bridal Veil, The Poet to the Painter, etc. Among her prose works are Clovernook, Married not Mated, Hollywood, and Pictures of Country Life.

THOMAS BAILEY ALDRICH (1836——), whose poems are Babie Bell, The Face Against the Pane, Friar Jerome's Beautiful Book, etc. His principal novels are The Story of a Bad Boy, Margery Daw and Other Stories, etc.

EDMUND CLARENCE STEDMAN (1833——), author of the Doorstep, Pan in Wall Street, At Twilight, John Brown of Ossawatomie, etc.

DR. J. G. HOLLAND (1819-1881); principal poems, Bitter-Sweet, Kathrina, and Mistress of the Manse. Some of his best prose works are Gold Foil, Lessons in Life, Plain Talks, Timothy Titcomb's Letters, etc.

FRANCIS BRET HARTE (1837——), whose best dialect poems are The Heathen Chinee, The Society upon the Stanislaus, In the Tunnel, etc. Of those in pure English are Dickens in Camp, The Mountain Heart's-ease, Concha, etc. Among the best of his prose sketches are The Luck of Roaring Camp, The Idyl of Red Gulch, The Outcasts of Poker Flat, etc.

CINCINNATUS HEINE MILLER (1841——), known as Joaquin Miller, author of Songs of the Sierras, Songs of Sun-Lands, and The Ship of the Desert, etc.

54. *Mention some of the prose writers of the American Age.*

WASHINGTON IRVING (1783–1859), whose most interesting works are Knickerbocker, Bracebridge Hall, The Sketch Book, The Alhambra, The Conquest of Grenada, Life of Washington, etc.

WILLIAM H. PRESCOTT (1796–1859); principal works, Ferdinand and Isabella, Conquest of Mexico, Conquest of Peru, etc.

GEORGE BANCROFT (1800–), whose great work is a history of the United States.

JOHN LOTHROP MOTLEY (1814–1877) ; great works, Rise of the Dutch Republic, History of the United Netherlands, and John of Barnaveldt.

JAMES FENIMORE COOPER (1789–1851), whose most popular novels are The Spy, The Prairie, The Last of the Mohicans, The Pilot. Besides these works he published Naval History of the United States, Lives of American Naval Officers, etc.

NATHANIEL HAWTHORNE (1804–1864). Of his many works may be mentioned the following; Twice-Told Tales, Mosses from an Old Manse, The Scarlet Letter, The House of the Seven Gables, The Blithedale Romance, and The Marble Faun.

MRS. HARRIET BEECHER STOWE (1812–), whose principal work is Uncle Tom's Cabin. The best of her other works are The Minister's Wooing, Oldtown Folks, Oldtown Fireside Stories, and My Wife and I.

EDWARD EVERETT (1794–1865), whose chief works are his orations, which are among the noblest ever written. Among his best efforts are his Address at the Dedication of the Dudley Observatory, and the Eulogy of Washington.

DANIEL WEBSTER (1782–1852), whose fame rests upon his ora-

tions and speeches. His masterpieces are his Plymouth Rock and Bunker Hill Orations, his Eulogy on Adams and Jefferson, and his great speech in reply to Hayne.

LOUIS J. R. AGASSIZ (1807–1873), most eminent naturalist of modern times ; principal works, Methods of Study in Natural History, Geological Sketches, and A Journey in Brazil (by himself and wife).

RALPH WALDO EMERSON (1803–1884), "the Sage of Concord," whose principal works are Representative Men, English Traits, and several volumes of Essays.

RICHARD GRANT WHITE (1822–); chief works, Edition of Shakespeare, Life of Shakespeare, and Words and their Uses.

HENRY WARD BEECHER (1813–), author of Star Papers, Eyes and Ears, Norwood, Yale Lectures on Preaching, etc.

SECTION III.

NATURAL PHILOSOPHY.

1. *Define Natural Philosophy.*

Natural Philosophy, or **Physics,** has for its objects the investigation of the properties of all natural bodies, and of their mutual action on each other. It is the science of causes and principles.

2. *Define matter, body, molecule.*

Matter is whatever occupies space. A **body** is any single mass, or portion of matter, whether great or small. A **molecule** is the smallest portion of a body which we can conceive of as retaining its identity. An *atom* is a division of a molecule.

Natural Philosophy deals only with *masses* and *molecules;* Chemistry deals with *atoms.*

3. *What are the general, or universal, properties of matter?*

The **universal** properties of matter, or those which are common to all bodies, are **weight, impenetrability, mobility, inertia, divisibility, porosity, compressibility, expansibility,** and **indestructibility.**

4. *What are the specific properties of matter?*

The **specific** properties of matter, or those which serve to distinguish one kind of matter from another, are **tenacity, hardness, brittleness, ductility, malleability, flexibilty,** and **elasticity.**

5. *What is meant by magnitude?*

By **magnitude** is meant the size of the body, or that it occupies a certain amount of space. Matter has three dimensions: *length, breadth, thickness.*

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6. *Define weight.*

Weight is the measure of the force which tends to draw all bodies on or near the earth to its center.

The mere measure of the attraction may be called *absolute* weight, and when the weight of one body is compared with another it is *specific* weight.

7. *Meaning of impenetrability ?*

By **impenetrability** we mean that no two bodies can occupy the same space at the same time.

8. *Meaning of mobility ?*

By **mobility** we mean the property of being moved, or having the position changed.

All bodies are in absolute motion, being carried around the axis of the earth and also around the sun, but we may be at rest in relation to other bodies on the earth's surface.

9. *What is inertia ?*

Inertia is that property of matter by virtue of which it tends to remain at rest when in a state of rest, or move on when in motion.

10. *What is meant by divisibility ?*

By **divisibility** we mean that matter is capable of being separated into distinct parts.

Theoretically there is no limit to the division of matter until we reach atom, but practically there is a limit long before we reach the molecule. The molecules of a body do not touch each other, but spaces exist between them. These spaces are called pores.

11. *What is compressibility ?*

Compressibility is that property of matter by virtue of which it may be made to occupy less space. It is a result of porosity.

12. *Meaning of expansibility ?*

Expansibility is the opposite of compressibility. The molecules are forced farther apart, and the body occupies more space.

13. *Meaning of indestructibility ?*

No particle of matter can be destroyed. The form may be changed, but the same number of atoms exists.

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A substance is consumed, we say, in the fire, but the gases and smoke and ashes will weigh as much as the substance did before.

14. *Meaning of tenacity.*

Tenacity is that property of some bodies by virtue of which they resist a force tending to pull the particles apart.

15. *Meaning of hardness, brittleness?*

Hardness is the resistance some bodies offer to an attempt to force a passage between their particles, and is measured by the readiness with which one body scratches another.

Bodies that are easily broken are said to possess the property of **brittleness.**

16. *Meaning of ductility, malleability?*

Ductility is that property by virtue of which a body may be drawn out into a wire.

Malleability is that property by virtue of which a body may be hammered or rolled into thin sheets.

Platinum is one of the most ductile of substances; gold is the most malleable.

17. *Meaning of flexibility, elasticity?*

Flexibility is that property of a body by virtue of which it may be bent or folded upon itself.

Elasticity is that property by virtue of which a body being compressed returns to its original form and bulk.

A body which, when bent, returns to its original state, is both flexible and elastic. If it remains bent it is flexible, but not elastic.

18. *What are the states of matter?*

Matter may be a **solid,** a **liquid,** or a **gas.**

The term fluid includes both liquids and gases. There is also claim laid to a fourth state of matter.

19. *What is a solid?*

A body is in a **solid** state when its molecules cohere so that their relative positions can not be changed without the application of considerable force.

20. *What is a liquid?*

A body is in a **liquid** state when its molecules cohere so slightly that their relative positions may be changed on the application of a slight force.

21. *Define the gaseous state.*

A body is in the **gaseous** state when its molecules tend to separate almost indefinitely from each other.

The term *gas* is generally applied to those bodies which are ordinarily in a gaseous state, and the term *vapor* to that which is formed by heating a liquid or solid.

22. *Define force.*

Force is whatever produces, destroys, or modifies motion. Heat seems to be the great **repellant** force in nature.

The terms *motion* and *force* are sometimes used interchangeably.

23. *Why can we not annihilate force?*

We can **change** but can not **annihilate** force. When a stone falls to the ground the force of gravity is expended and its motion apparently stops; but if we examine closely we will find that it is warmer than before. The molecules which compose it have been set in motion and we have heat, another kind of force. Again, the sun's light and heat are forces which cause plants to grow. Wood and mineral coal are, therefore, transmuted sunshine. In combustion the solar energy again appears as heat, or may be applied as a moving force for engines. Food is transmuted by animals into animal heat and muscular energy.

24. *Define terrestrial gravitation.*

Terrestrial gravitation, or **gravity,** is the tendency of every body to fall toward the center of the earth, due to the mutual attraction of the earth and body.

25. *Meaning of energy of position and energy of motion, respectively?*

A stone elevated above the level of the earth has **energy of position,** for although it remains passive it possesses the power of performing work, or overcoming resistance if allowed to fall. A stone falling has **energy of motion.**

The water of a mill pond or lake which is elevated above the surrounding country has energy of position. If the water flows over a dam its weight and velocity give it power to move machines, and we call it energy of motion.

26. *Name the forces which act on the molecules of matter.*

They are **cohesion, adhesion, heat, light, electricity, magnetism.**

27. *Define cohesion and adhesion.*

The molecules of a solid body are held together by a force we call **cohesion.** One kind of solid is held to another kind by a force we call **adhesion.**

28. *What causes motion in a circle?*

A body moving in a circle must be acted upon by two forces, one drawing it to the center, called the **centripetal force;** and the other, that by which it tends to move in a straight line from the center, called the **centrifugal force.** The result of the combined forces is to make the ball move in a circle.

29. *What is universal gravitation?*

The attraction between distant bodies, as the earth, sun, moon, and planets, we call **universal** gravitation.

30. *What is the great law of gravitation?*

Gravitation **varies directly as the mass and inversely as the square of the distance.**

(1) If one body has twice the amount of matter that another body has it will attract a third body with twice the force. If the amount of matter be doubled the force of attraction is doubled, and so on. (2) If one body be twice as far from another at one time as it is at another time, its attraction in the first case will be only one-fourth as great as in the second case. If the distance be three times as great, the attraction will be only one-ninth, and so on.

31. *What is weight?*

Weight is the measure of the force of gravitation.

A body weighs most at the surface of the earth because it is then attracted by the entire mass of the earth acting at a short distance. Below the surface it weighs less because the entire mass does not act upon it in the same direction. Away from the surface it weighs less because the force decreases according to the law in the preceding answer.

32. *Define specific gravity.*

Specific gravity is the ratio between the weight of a body and the weight of an equal volume of another body taken as a standard.

The standard for solids and liquids is distilled water at a temperature of 39.2° F., or 4° C. For gases the standard is air or hydrogen.

33. *How find the specific gravity of solids?*

Weigh the body in air. Then weigh it suspended in water. It will lose in weight as much as the weight of the water it displaces. It will displace its own bulk of water. Its loss of weight in water then will equal the weight of an equal bulk of water. If the weight in air be divided by the loss of weight in water the quotient will be its specific gravity.

If the body is lighter than water attach it to a body heavy enough to sink it. Find the loss of weight of the two combined, also for the heavier body. The difference between the two combined and the loss of the heavy body divided into the given body will equal the specific gravity.

34. *Describe a way to find the specific gravity of liquids.*

The most convenient way is by means of the hydrometer, an instrument which can be constructed so as to represent the principle as follows: Take a long, narrow test tube and fill with sand until it will just sink to a depth of 100 degrees. If this tube sinks to exactly 100 degrees in distilled water at a temperature of 39.2° F., it will, if immersed in other liquids, sink to a greater or less depth, according as they are lighter or heavier than water. Thus, in alcohol it will sink 125 degrees. $100 \div 125 = .80$, the specific gravity of alcohol.

35. *How find the specific gravity of gases?*

Fill a vessel with the gas and weigh it. Then weigh the same vessel filled with air or hydrogen, whichever is to be taken as the standard. The weights of equal volumes are then known, and the comparison can be made.

36. *What are general laws of falling bodies?*

(1) All bodies fall with equal rapidity, or traverse the same distance in the same time, irrespective of weight or size, provided there be no resistance of air.

(2) A body falls 16 feet in the first second, and attains a velocity of 32 feet at the end of the second. The velocity attained at the end of each succeeding second is found by multiplying 16 by the respective even numbers 4, 6, 8, 10, etc., and the distance traversed in each second by the respective odd numberr 3, 5, 7, 9, etc.

(3) The whole distance traversed in a given number of seconds is found by multiplying 16 feet by the square of the number of seconds.

The same principles apply, in a reverse order, to bodies thrown upward.

37. *Meaning of the center of gravity?*

The **center of gravity** is that point in a body about which all the matter is evenly balanced.

38. *How find the center of gravity?*

Suspend a body from any point. Drop a plumb-line from the point of suspension and mark its direction. Suspend the body from any other point not in line with the first, and mark the plumb-line as before. The center of gravity will lie directly under the point of intersection of these lines.

39. *When is a body in stable equilibrium? Also in unstable equilibrium?*

When the center of gravity of a body falls within the base of support, the body will return to its position when slightly displaced, and is said to be in **stable equilibrium.**

When a body is supported so that when slightly displaced it falls further from its position, it is said to be in **unstable equilibrium.** In this case the center of gravity is without, or above, the point of support.

40. *When is a body in neutral equilibrium?*

When a body is supported so that when slightly displaced it tends neither to return nor fall further from its position, it is said to be in **neutral,** or **indifferent equilibrium.** The center of gravity in this case is neither raised nor lowered.

41. *What is the line of direction?*

A plumb-line let fall from the center of gravity is called the **line of direction.**

When this line falls within the base, the body stands; when without the base, the body falls.

42. *What is a pendulum?*

A **simple pendulum** is conceived to be a heavy material particle, suspended by a line without weight, and oscillating about a fixed point.   A simple pendulum exists in theory only.

The **compound** pendulum consists of a weight suspended so as to swing freely to and fro.

43. *Describe the oscillation of the pendulum.*

When the weight is drawn up so that the bar or string is no longer in a vertical position, the force of gravity brings the weight to the lowest point and inertia carries it onward until stopped by gravity, when it returns and passes beyond the lowest point again on the other side, each **oscillation** becoming shorter until it is finally brought to rest by friction and resistance of the air.

The path which the weight traverses is called the **arc,** and the extent to which it travels on either side is called its **amplitude.**

44. *What are the laws of the pendulum?*

(1) The oscillations, or vibrations, of the same pendulum in the same place on the earth, will be performed in the same time, irrespective of the length of the arch.

(2) The weight or material of which the pendulum is composed does not affect its vibration.

(3) The times of vibrations of different pendulums are proportional to the square roots of their respective lengths.

(4) The same pendulum will vibrate in different times at different places on the surface of the earth; slowest at the equator, most rapidly at the poles.

45. *What is the center of oscillation?*

The upper part of a pendulum tends to move faster than the lower part.   There is a point in its length which tends to move at an average rate, the particle of matter at this point oscillating as if it were suspended by a string without weight, thus fulfilling the conditions of the simple pendulum.   This point lies a little below the center of gravity, and is called the **center of oscillation.**

The real length of the pendulum, then, is the distance from the point of suspension to the center of oscillation.

46. *Name the uses of the pendulum.*

(1) It regulates our clocks.   (2) It is used in ascertaining the dimensions of the earth.   (3) To measure the velocity of falling bodies.   (4) To prove the revolution of the earth.

47. *Meaning of momentum.*

The product of the mass and velocity of a body is called its **momentum.** It is sometimes called its quantity of motion.   For example, a body moving at the rate of 2 feet per second and weighing 4 lbs. will have a momentum of 8, which will be the same as if the body weighed 2 lbs. and was moving at the rate of 4 feet per second.

48. *What is the distinction between the striking force of a body and its momentum?*

The striking force denotes the **amount** of force necessary to bring the body to a state of rest, if applied for one unit of time. The latter denotes the force required to keep a body in motion with a constant velocity or to overcome resistance through a unit of space.

49. *Illustrate momentum.*

Though a 4 lb. ball with a velocity of 2 ft. per second will have the same momentum as a 2 lb. ball with a velocity of 4 ft. per second, yet the latter will penetrate farther into any body which it may strike.   In the case of a rifle, the velocity of the ball multiplied by its weight represents its momentum.

The force of the powder acts as powerfully against the gun as against the ball, but the gun is not sent backward with the same velocity that the ball is sent forward.   Its velocity, however, multiplied by its weight, will equal the velocity of the ball multiplied by its weight.   The *momentum* of the gun is the same as that of the ball, but the striking force of the ball is the greatest.

50. *How find the striking force of a moving body?*

The **vis viva,** or striking force, equals ½ **the square** of the **velocity,** multiplied by the **mass.**

51. *Chief resistance to motion?*

**Resistance** of the air ; **Friction; Gravity.**

52. *Define friction.*

Friction is that resistance which one body meets when made to move on the surface of another. It is of two kinds, *sliding* and *rolling.*

The projections of one body fall into the indentations of another, and thus lock them so that force is necessary to move them. Grease, oils, and other substances by filling up these indentations diminish friction.

53. *What is meant by the parallelogram of forces?*

If a ball at A be met by a force sufficient to carry it to C, the ball will move in the direction of A D, or in the di-agonal of the figure, which is called the **parallelogram of forces.**
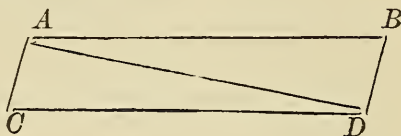
The line *A D* is called the **resultant** of the two forces represented by the lines *A B* and *C D.*

54. *Define circular motion.*

Circular motion is the resultant of centrifugal and centripetal forces. (*See question 28.*)

When one body is thrown against another, if one or both bodies are elastic, the projected body will rebound according to the law: **the angle of inci-dence is equal to the angle of reflection.**

55. *What is a machine?*

A machine is an instrument by means of which a force, applied to a certain point, is made to exert force at another point, more or less distant.

The force employed in a machine is called the *power.* The resistance overcome by a machine, at the point where the power acts, is called the *weight* or load.

56. *Define a horse-power.*

A horse-power is the mechanical value of a force capable of raising thirty-three thousand pounds one foot in one minute. Its work is, therefore, equal to thirty-three thousand foot-pounds in a minute.

Thus, one-horse power can raise one thousand pounds thirty-three feet high in one minute, or five hundred and fifty pounds one foot high in a second, or one million nine hundred and eighty thousand foot-pound in an hour.

57. *What is the fundamental law in all machinery?*

What is gained in power is lost in time or velocity. Hence, if any machine will enable us to lift a weight of ten pounds by a power of one pound, the power must move ten times the space traversed by the load; as the spaces are traversed in the same time, the power must move ten times as fast as the load.

58. *What laws are applicable to machines of all kinds?*

(1) The power multiplied by the vertical distance through which it passes equals the load multiplied by the vertical distance through which it passes.

(2) The power multiplied by its velocity equals the load multiplied by its velocity.

59. *What are the advantages derived from the use of machinery?*

(1) It enables us to employ our whole force at the same time.

(2) It enables us to change the direction of our force.

(3) It enables us to perform work we could not do with our unassisted strength.

(4) It enables us to employ other forces than our own, as the strength of animals, the forces of wind, water, and steam.

(5) It enables us to utilize the products of nature.

60. *Name the six elementary forms of all machines?*

The **simple machines** are (1) the lever, (2) the wheel and axle, (3) the pulley, (4) the inclined plane, (5) the wedge, (6) the screw. A combination of two or more of these constitutes a **compound** machine.

There are really only two elementary forms, the lever and the inclined plane, the others being but modifications of these two.

61. *What is the lever?*

A **lever** is an inflexible bar capable of turning on a fixed point. The force used is called the **power,** the object to be moved, the **weight,** and the fixed point or pivot, the **fulcrum.**

62. *Name the kinds of levers.*

(1) Lever of the **first class:** power at one end, weight at the other, fulcrum between them.

(2) Lever of the **second class**: power at one end, fulcrum at the other, weight between them.

(3) Lever of the **third class**: fulcrum at one end, weight at the other, power between them.

A **compound** lever consists of several levers connected together in such a way that the short arm of one acts upon the long arm of the next and so on.

63. *Describe the wheel and axle.*

The **wheel** and **axle** is a modification of the lever in which the center of the axis is the fulcrum, the distance from the rim of the wheel to the axis or the length of the crank, the long arm, and the distance from the circumference of the axis to its center its short arm.

64. *Describe the pulley.*

The **pulley** is a modification of the lever, where the distances from the axis to the circumference represent equal arms of the lever. No advantage is gained in a fixed pulley except change of direction. By means of a number of movable pulleys the power distance is increased, the cord having to pass through a greater distance to gain greater power.

65. *What is an inclined plane?*

An **inclined plane** is a smooth, hard surface inclined so as to make an angle with direction of the force to be overcome.

When a weight is placed upon such a plane, a part of the pressure is resisted by the plane, while the remainder tends to cause the weight to slide or roll down the plane.

66. *What is the wedge?*

The **wedge** is simply a movable inclined plane, its power depending upon friction as well as upon its form.

67. *Describe the screw.*

The **screw** is an inclined plane wound around a cylinder.

68. *Upon what does the solid condition of matter depend?*

Upon the **cohesion** of its molecules. (*See answer to Question 27.*) Cohesive force acts at insensible distances. The process of *welding* metals illustrates the principle of cohesion. Oil, water, quick-

silver, etc., collect in drops by virtue of the cohesion of the molecules.

69. *Meaning of adhesion?*

Adhesion is the force which binds molecules of one kind to the molecules of another kind. On this principle glue fastens wood together, mucilage fastens paper, mortar cements bricks, solder fastens tinware, dust clings to the wall, paints to objects, liquids to solids, etc.

70. *Name the principal varieties of adhesion.*

Capillarity, diffusion of liquids, diffusion of gases, osmose.

71. *Define capillarity.*

Capillarity, or **capillary attraction**, is that form of adhesion by virtue of which liquids tend to rise upon the surface of solids. When the vertical sides of two solids are brought very near together, as in the case of fine tubes, or when two plates of glass are placed together, or as in the fibers of cloth or paper, liquids will rise to a considerable height upon the principle of capillary attraction.

Blotting paper absorbs ink, the wick of the lamp draws up the oil, the earth absorbs water, and many other phenomena are explained on this principle.

72. *Meaning of diffusion of liquids and of gases?*

Liquids of different densities will gradually mix by virtue of the adhesion of their molecules. This is called **diffusion of liquids.** The same is true of **gases.**

73. *Meaning of osmose?*

When liquids or gases of different densities are separated from each other by a thin porous membrane, or by a porous substance like plaster of paris, they will mingle, not uniformly, but varying with the nature of the substances. Thus, if a bladder be filled with alcohol and immersed in a vessel of water, the alcohol will mingle with the water, passing into the bladder. This operation is called **osmose.**

74. *Of what does Hydrostatics treat?*

Hydrostatics treats of liquids in a state of rest. Liquids transmit pressure equally in all directions.

Pressure exerted anywhere upon a mass of liquid is transmitted undiminished in all directions and acts with the same force upon equal surfaces and in a direction at right angles to those surfaces. A necessary deduction from this law is that surfaces of vessels sustain a pressure proportional to their area.

75. *Upon what principle does an Artesian Well act?*

Upon the principle that liquids press equally in all directions, that water " always seeks its level."

The water will be thrown nearly as high as the fountain head, being retarded somewhat by friction and resistance of the air.

76. *What is the spirit level?*

If a glass tube be filled with any liquid so that it holds only a bubble of air, and placed in a horizontal position, the bubble will stand at the center of the tube, explained on the principle named in preceding answer.

As alcohol, which will not freeze, is the fluid generally used, it is called the **spirit level.**

77. *Of what does Hydraulics treat?*

Hydraulics treats of liquids in motion.

The velocity of a jet of water is equal to the velocity of a body falling from the same height.

78. *How find the quantity of water discharged in a given time?*

Multiply the velocity by the area of the orifice and that product by the time.

A stream runs more swiftly in the center and at the surface than near the banks or at the bottom, because the friction of the shores and bottom retard it.

79. *Of what does Pneumatics treat?*

Pneumatics treats of the physical properties of gaseous bodies.

The principles of transmission of pressure, specific gravity, and buoyancy of liquids, apply also to gases.

80. *Describe the air-pump.*

The **air-pump** is a machine for removing the air from within a vessel. It consists of a cylinder supplied with a valve opening inward and one outward, and a piston fitting accurately. When the piston is raised the air rushes into the cylinder through the first valve to fill the vacuum; as the cylinder descends the air

closes the first valve and opens the second, and is driven out. Every stroke of the piston thus removes a portion of the air. The second or escape valve, may be in the side of the cylinder or in the piston itself.

81. *What are the properties of gases?*

Gases have weight, compressibility, expansibility, and elasticity.

82. *What is the pressure of the atmosphere?*

The **pressure** of the air is equal to about fifteen pounds to the square inch at the level of the sea, being the weight of a column of mercury one inch in area, and about thirty inches in height, which will be sustained by a column of air one inch in area.

The pressure of the atmosphere at sea level will sustain a column of water about thirty-four feet in height.

83. *Describe the action of the common pump.*

The piston, or sucker, being raised the water is forced up the tube by the pressure of the air on the surface of the water in the well, there being no resistance in the tube, for the piston produces a vacuum by lifting the air out. As the piston descends, the valve in it opens upwards and allows the water to pass through above the valve, which, closing as it rises again, the water is lifted out and more is forced into the tube below.

Owing to the necessary imperfection of the parts, water can not be raised by atmospheric pressure more than about twenty-seven feet.

84. *Describe the barometer.*

The **barometer** is an instrument for the measurement of atmospheric pressure. It is useful in ascertaining heights above sea level and for estimating the condition of the weather. It consists essentially of a glass tube, with a graduated scale affixed. As the instrument is carried up a height, the mercury falls, being subject to less pressure, and *vice versa.*

85. *Describe the siphon and its action.*

The **siphon** consists of a tube bent in the shape of the letter U with unequal arms.

Fill the siphon with water, closing both ends with the fingers. Insert the short arm in a vessel of water with the long arm on the outside with

its end lower than the end of the short arm. The column of water in the long arm will run out by its own weight and the tendency would be to produce a vacuum in the bend of the tube, but the water is forced up by the pressure of air through the short arm, and thus the stream is kept up so long as the outside arm is lower at the orifice than the orifice of the inside arm. The flow may be started by exhausting the air from the long arm by suction, then it will not be necessary to fill the siphon with water.

86. *Define Acoustics.*

Acoustics is the science which treats of the cause, nature, and phenomena of sound.

87. *What is sound.*

Sound is the sensation produced in the brain through the auditory nerve from vibrations of matter.

There can be no sound without an organ of hearing; but there may be vibrations of matter which would produce sound were there an organ to transmit it and a brain to receive it.

88. *What of the velocity of sound?*

The **velocity** of sound depends upon the nature of the medium through which the vibrations are transmitted.

Sound travels through air (at the freezing point) at the rate of 1,090 feet per second; through water at the rate of 4,700 feet per second.

89. *How does sound travel?*

As sound is transmitted to the ear through a **medium** like air or water, it travels in waves, the molecule swinging back and forth.

The **amplitude,** or distance the molecules move back and forth, determines the **intensity** of the sound. The intensity of sound varies inversely as the square of the distance of the sounding body.

90. *Meaning of reflected and refracted sound, respectively.*

When sound waves strike the surface of an opposing medium a part of them are thrown back, or **reflected.** The angle of incidence is equal to the angle of reflection as in reflected motion.

If sound waves strike a medium of different density those waves which are transmitted are **refracted,** or bent out of their course.

91. *What is a musical note?*

Regular vibrations when produced with sufficient rapidity blend into one sound. This is a **musical** note. A succession of musical notes so modulated as to please the air constitutes **music.**

92. *What is the Telephone?*

The **Telephone** is an instrument which reproduces articulate speech or other sounds at a distance.

In the string telephone it is only necessary to have a membrane which can be set in vibration by the impulses of the air made by the voice on an instrument, and a string or wire attached to it to carry the vibrations to a similar membrane at the other end. This second membrane gives back to the air the same kind of vibration received at the other end.

In the electric telephone the vibrations of the membrane cause changes in the electric current produced by a battery, those changes being capable of reproducing the same kind of vibrations in the membrane at the opposite end.

93. *What is the Phonograph?*

The **Phonograph** is a machine which writes sounds on a strip of tin foil and reproduces them with great distinctness. It consists of a mouth-piece and vibrating membrane the same as the telephone, with a needle attached to the center of the membrane the vibrations of which cause the needle to make impressions in the tin foil, which is rolled on a grooved cylinder made to revolve. By so adjusting the machine that the needle may retrace its path on the tin foil, the membrane is set in vibration again and the sounds are given back exactly as they were received.

94. *What is light?*

Light is that mode of wave motion which affects the optic nerve, producing the sensation of vision.

When light passes through a body so as to enable objects to be seen distinctly beyond it, the body is **transparent**; when light passes through but not sufficient to allow the perception of objects, it is **translucent**; when no light passes through, it is **opaque.**

95. *Meaning of visual angle?*

Light always moves in straight lines. The angle formed at the eye by the rays coming from the extremities of an object is called **visual** angle.

96. *Define the wave theory of light.*

It assumes, (1) that matter of extreme rarity and elasticity, called *luminiferous æther,* pervades all space. (2) That the molecules of luminous bodies are in a state of very rapid vibration. (3) That these vibrations are communicated to the æther and are then transmitted in all directions by spherical waves. And (4) that these waves or vibrations constitute light.

97. Meaning of luminous and of non-luminous bodies.

Luminous bodies are those in which light originates; as the sun and burning bodies. **Non-luminous** bodies do not originate light, but may be rendered temporarily luminous by the presence of a self-luminous body; thus, a lighted candle renders adjacent objects luminous.

98. Name the sources of light.

The **sources** of light are (1) mechanical action, (2) chemical action, (3) electricity, (4) phosphorescence, and (5) the heavenly bodies.

99. How, and at what rate, does light move?

Light passes from a luminous body equally in every direction and travels through a medium of uniform density in straight lines. It moves at the rate of about 185,000 miles per second. The **intensity** decreases inversely as the square of the distance.

100. Meaning of reflected and refracted light?

When a beam of light from a luminous body falls upon the surface of an opaque body a portion is **reflected,** or thrown back, and a portion absorbed,—the angle of incidence is equal to the angle of reflection. When light passes from one medium to another of different density, it is **refracted,** or bent out of its regular course.

101. What is a lens, and what are the two principal kinds?

A **lens** is a transparent body, generally of glass, having one or two curved surfaces. Lenses are of two principal kinds, **convex** and **concave.** A convex lens converges the rays of light, or brings them to a focus at a point varying in distance according to the degree of convexity. A concave lens causes the rays of light to diverge.

102. Name the seven original colors, or the colors of the solar spectrum?

Violet, indigo, blue, green, yellow, orange, red.

8

103. *Name the three classes of rays in the solar spectrum?*

Calorific, or heat rays; **colorific,** or color rays; and **actinic,** or chemical rays.

The heat is the greatest in the red rays; the actinic power in the violet.

104. *What are the sources of heat?*

The **sources** of heat are the *sun, moon,* and *stars; mechanical action; chemical action.*

The greater part of the heat of our globe comes from the sun, a very minute quantity from the other heavenly bodies.
Great heat may be developed by mechanical action, as friction and concussion.
Chemical action is seen in the combustion of fuel, the union of oxygen with carbon and hydrogen; also in the heat of the blood, caused by the union of oxygen and carbon.

105. *Define specific heat?*

The amount of heat necessary to raise a given body one degree in temperature compared to that required to raise the same quantity of water one degree, is called **specific** heat. It expresses the relation between latent and sensible heat.

All bodies expand under the influence of heat; all bodies contract by cold.

106. *What is the Thermometer?*

The **thermometer** is an instrument to measure the temperature by means of the expansion of mercury. Mercury freezes at 40°F. below zero; alcohol is used for very low temperatures.

The principal scales used are **Fahrenheit's,** in which the space between the two fixed points, boiling and freezing, is divided into 180 degrees; the **Centigrade,** in which this space is divided into 100 degrees; **Reaumer's,** in which it is divided into 80 degrees.

107. *What of the distribution of heat?*

Any heated body returns, sooner or later, to the temperature of surrounding bodies. This tendency of heat to maintain an equilibrium of temperature is due to a continued exchange of molecular motions by virtue of which every molecule tends to produce in contiguous molecules its own rate of vibration.

108. *What are the three ways in which heat may be transferred from one body to another?*

(1) By **conduction,** or from molecule to molecule; (2) By

convection, or by motion among molecules; (3) **By radiation,** or by thermal undulations through space.

109. *What is electricity?*

Electricity is a polar force which becomes manifest by its peculiar phenomena of attraction and repulsion. It is now regarded as a mode of molecular motion, which is always manifested in two opposite or polarized states.

110. *What are the two general ways in which electricity manifests itself?*

(1) On the surface of bodies and capable of sudden and intense effects, called **statical electricity;** (2) as a continuous current, or moving energy, called **current electricity.**

111. *How is statical electricity produced?*

It is generally developed by friction. It is also produced by pressure, evaporation, and other agencies.

112. *Define frictional electricity?*

If a rubber comb, a lamp chimney, or a stick of sealing wax, be rubbed vigorously with a piece of cloth and held over small bits of paper they will be attracted, and then repelled. In cold, dry weather, peculiar phenomena are noticed, such as a crackling sound when the hair is combed with a rubber comb, sparks produced when a cat's back is rubbed in the dark, etc. These phenomena are due to **frictional** electricity.

113. *Meaning of conductors and non-conductors?*

Substances which allow the electricity to pass through them are called **conductors.** Those which do not allow the electricity to pass through are called **non-conductors,** or **insulators.**

Metals, charcoal, liquids, moist leather and animal and vegetable tissue are good conductors. Glass, silk, india rubber, dry wood, feathers, dry air, and gases are non-conductors.

114. *What is the law of electrical action?*

The positive attracts the negative and the negative attracts the positive; the positive repels the positive, and the negative repels the negative; or, in other words, bodies charged with *like electricities repel*, and bodies charged with *unlike electricities attract.*

115. *What is an electrical machine?*

It is an apparatus by means of which large supplies of statical electricity may be developed in a convenient manner.

There are several kinds in use. The essential parts of one kind, the *friction machine*, may be briefly described as follows: A glass plate or cylinder is arranged so that it can be turned with a crank and caused to rub against cushions of leather on which is spread an amalgam of tin, zinc, and mercury. As the glass is revolved the rubbing of the cushion develops positive electricity on the glass and negative on the rubber. To collect and concentrate these electricities conductors are necessary. They consist simply of hollow cylinders of metal, as brass or common tinware. These conductors are insulated by glass posts and the one for the positive electricity, called the prime conductor, is provided with a rod containing several sharp points which come very near the glass plate and cylinder. The negative conductor is also insulated and connected by pieces of metal with the rubbing cushion. A piece of silk in the form of a bag is suspended under the plate or cylinder to prevent the escape of electricity to the ground.

To get an effect from the machine connect the negative conductor by a chain or wire with the floor or earth, and turning the crank bring the hand near the end of the prime conductor farthest from the glass. A spark will be seen and a shock felt.

116. *Describe the Leyden jar.*

The **Leyden jar,** or condenser, consists of a glass jar or bottle coated both on the inner and the outer surface with tin foil to within three inches of the neck. The mouth is usually closed with a plug of varnished wood, through which passes a brass wire surmounted by a knob, and connected to the inner coating by means of a chain.

If the jar be held near a machine in action the sparks will pass from the machine to the interior of the jar; but after a little while this will cease, and the jar is then said to be charged. To discharge the jar the inner and outer coatings must be brought in connection by some conducting substance. If you hold the jar so that one hand touches the outside and bring the other hand to the rod communicating with the inside, your body is the conducting medium and you receive a *shock*, dangerous if the jar is heavily charged. The jar may be so heavily charged as to shock a hundred persons who form a circle by joining hands.

117. *What is lightning?*

Lightning is the effect of **atmospheric electricity.** It is the passage of the electricity from one cloud to another, and is similar to the discharge of a Leyden jar.

The famous kite experiment of Franklin established the identity of atmospheric electricity with that produced by the electrical machine.

118. *Cause of the Aurora Borealis?*

The **Aurora Borealis,** or northern light, is caused by the passage of currents of electricity through the rarified air of the upper regions.

Lightning rods protect from the effects of lightning by enabling the opposite electricities of the earth and cloud gradually to neutralize each other; also by affording a passage for electrical discharges.

119. *What is magnetism?*

Magnetism is that form of electric energy exhibited by the **magnet,** a body which has the property of attracting iron, and if suspended so as to turn freely, assumes a north-and-south direction.

The natural magnet, or *loadstone,* is an ore of iron. An artificial magnet is a magnetized piece of steel, either straight or bent in the form of a horseshoe. The needle of the mariner's compass is a straight magnet, balanced so as to turn freely.

120. *What is Voltaic, or galvanic electricity?*

If a piece of copper and a piece of zinc be placed in water containing a little sulphuric acid, and the ends of the copper and zinc be brought together or connected by wires, a current of electricity will be established between them. A spark may be seen in the dark, if the two wires are brought near together, but not in actual contact. This electricity is produced by the chemical action of the acid on the metal and is called **Voltaic,** or **galvanic electricity.**

A glass vessel containing the metals and acid is called a *cell,* and several cells connected together constitute a *galvanic battery.* The metal plate in which the chemical action is greatest is called the positive plate and the other the negative plate. The free ends of the wires are called electrodes; the one attached to the positive plate is the negative electrode, and *vice versa.*

121. *What are thermo-electric currents?*

If two pieces of different metals be soldered together and heated at their junction, an electric current will be started. If they be cooled, the current will pass in the opposite direction. These are called **thermo-electric** currents.

122. *What is the magneto-electric machine?*

The **magneto-electric** machine consists of two coils of insulated copper wire wrapped on cores of soft iron and made to revolve near the poles of a horseshoe magnet. Each time they come near the poles they receive an impulse, and these impulses succeeding each other rapidly, a current is produced in the cells.

123. *Mention some of the important applications of electricity.*

The **telegraph,** the **telephone, electrolysis,** the processes of **electroplating** and **electrotyping,** and the **electric light.**

124. *What are the four parts of which the telegraph consists?*

The **electric** telegraph is by far the most important application of electricity to the practical affairs of life. Every electric telegraph consists essentially of four parts: (1) a Voltaic battery for generating a current; (2) a circuit consisting of an insulated metallic connection between two places; (3) a *key,* which is an instrument for sending signals from the one station, and (4) an instrument for receiving signals at the other station. [*For description of the telephone, see answer to question 92.*]

125. *What is electrolysis?*

It is the operation of effecting the decomposition of chemical compounds by means of a current of electricity.

126. *What is electroplating?*

It is the process of depositing one metal on the surface of another by means of a Voltaic battery. The articles to be plated are hung on a rod connected with the negative electrode and suspended in a solution of a compound of the metal to be deposited. Plates of the metal to be deposited are hung in the solution on a rod connected with positive electrode. The thickness of the deposit depends on the time the operation lasts.

127. *Describe electrotyping.*

Electrotyping is the process of making perfect copies of surfaces by means of a removable metallic deposit. Nearly all books are printed from electrotype plates. This book is so printed.

When a medal has been electro-coppered, the coating, if sufficiently thick to be stripped off whole, will give a surface the exact reverse of the medal even to the finest lines. If this reversed copy, or mold, be attached to the negative electrode, a second copy may be formed which will exactly resemble the original.

Any object may be copied in this manner, but in the ordinary processes of electrotyping it is usual (1) to form a mold of the object in wax, gutta percha, or plaster, and (2) then to deposit within this a sufficiently thick coating of some metal, which is usually copper.

Thus, suppose we desire to electrotype a page of type. It is first rubbed

over with graphite to make it a conductor, and the excess of graphite blown off; then (2) an impression is taken in wax, and the wax coated with graphite as before ; (3) a copper wire is now thrust through the wax and made to connect with the layer of graphite; finally (4) it is made the negative electrode in a bath of sulphate of copper. A tough coat of copper will gradually be deposited on the surface of the graphite, and after a day or two will be sufficiently thick to be removed.

128. *Describe the electric light.*

On breaking and closing a Voltaic circuit a spark usually appears, which varies in size with the strength of the battery. When the current of a powerful battery passes through a circuit interrupted by carbon rods placed a short distance apart, a brilliant light of very high temperature is produced.

It is partly due to combustion, but mainly to incandescent particles of carbon moving between the points of the rods, chiefly toward the negative electrode.

SECTION IV.

CHEMISTRY.

1. Define Chemistry.

Chemistry is that branch of science which treats of the composition of bodies, or of the changes which take place in matter whereby it loses its identity.

2. What is an element; also a compound?

Any substance or mass of matter which can not be separated into two or more distinctly different substances is an **element,** or simple substance, or an ultimate element.

Any substance which can be separated into two or more distinctly different substances is a **compound,** or a compound substance, or a proximate element.

3. What is meant by chemical affinity.

Chemical affinity is the force which holds together the elements of compounds.

Compounds are formed by the chemical union of two or more simple elements. Substances whose elements are not held together by chemical affinity are called **mixtures.** A mixture partakes of the nature of each ingredient. A compound differs from any of its ingredients.

4. What is the number of simple elements?

The number at present recognized is 64.

Oxygen, the most abundant of the elements, exists free in the atmosphere, simply mixed with nitrogen, which also is free, but on account of the great affinity oxygen has for other substances, almost everything else has oxygen combined with it. The term *native* is used especially in the case of metals to indicate that a substance is found free. Gold is usually found native, because it will not unite with oxygen under ordinary conditions.

5. Define chemical combination and chemical decomposition.

Chemical combination is the union of two or more simple or

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compound substances to form another substance differing from any of the ingredients.

Chemical decomposition is the separation of the elements of a compound, or the breaking up of a single substance into two or more simpler substances.

If hydrogen and oxygen gases be mixed and heat applied they will combine with great violence, the result being water. When wood burns, the carbon is separated from the other elements (decomposition) and unites with the oxygen of the atmosphere (combination) to form carbonic oxide.

6. *What is chemical action?*

This changing of the elements of matter, destroying unions and making new ones, is called **chemical action.**.

Heat, light, and electricity favor chemical action, either to cause combination or decomposition of substances. Solution, by destroying the cohesive force in a body, also favors chemical action.

7. *Give examples of chemical action favored by different forces.*

(1) If some baking powder be mixed with cream of tartar no action will ensue until water is added to the mixture, when vigorous action immediately follows.

(2) If a piece of sulphur be placed on a hot stove it takes fire and produces white fumes which have a strong odor, and which in analysis will be found to be a third substance formed of sulphur and oxygen and called sulphuric oxide, the combustion being simply the union of the oxygen of the air with the sulphur.

(3) If a current of electricity be passed through water it will be separated into its constituent elements, oxygen and hydrogen.

(4) If a piece of paper be moistened by a solution of silver nitrate, and exposed to the sunlight, it will turn black, a change due to the decomposition of the silver nitrate.

(5) If hydrogen and chlorine gases be mixed in the dark, and the bottle containing them taken into the sunlight, an explosion follows, being the combination of the two gases; a new substance, hydrochloric acid gas, is formed.

8. *Explain the Symbols used by chemists.*

The symbolism consists of the initial letter or letters of the name of the element. Where more than one element begins with the same letter or letters, the second or third letter is also used. Compounds are represented by writing the symbols of their elements in close connection. Thus, C is the symbol for carbon, but

as chlorine begins with the same letter, Cl is used for that element. Cu for copper from the Latin name cuprum, and H_2O is the symbol for the compound element, water. When a symbol stands without any figures attached, as H, it means an atom of that element. When a small figure is written below, it means that a corresponding number of atoms is taken. Thus, H_2 means two atoms of hydrogen. H_2O means two atoms of hydrogen and one of oxygen.

9. *How are the elements classified?*

The elements are divided into two classes as to their action in the process of decomposition.

(1) **Positive,** those which are attracted to the negative pole;

(2) **Negative,** those which are attracted to the positive pole.

10. *How are the elements named?*

Many of the long known substances retain their old names, as iron, gold, silver, lead, sulphur, etc., but in symbolizing, the initials of the Latin names are used, as Fe, ferrum ; Au, aurum ; Ag, argentum, etc. The more recently discovered metals have generally received names ending in **um** and so called from some peculiar property or from the name of the compound substance from which they were separated.

EXAMPLE.—Sodium, potassium, selenium, etc. Names of compound substances are found by combining, according to certain rules, the names of the simple elements composing them : Example,—Sodium chloride, hydrogen sulphide, potassium chlorate. Certain non-metallic elements having some resemblance have received names with similar terminations, as bromine, iodine, chlorine, etc.

11. *What is a binary compound?*

Binary compounds are those formed by the union of two elements, one of which is positive to the other, which is negative. All such compounds are named by placing the positive element first followed by the name of the negative element changing its termination to **ide,** as sodium and chlorine unite to form sodium chloride, silver and sulphur to form silver sulphide, etc. When the positive element combines in two different proportions, the termination **ic** is given to the positive element when it has the greater proportion, and **ous** when it has the lesser proportion ; as mercuric oxide and mercurous oxide. When the proportion is still less

than **ous** it takes the prefix **hypo,** as hyponitric oxide; when greater than **ic** it takes the prefix **per,** as perchloric oxide.

12. *What is a ternary compound?*

Ternary compounds are those which have dissimilar atoms united by means of a third atom. They are formed directly by the union of two binary compounds, or by the changing of atoms from one to another.

13. *Define acids, bases, and salts.*

An **acid** molecule is one which consists of one or more negative atoms united by oxygen to hydrogen. A **basic** molecule consists of one or more positive atoms united by oxygen to hydrogen. A **saline** molecule is one which contains a positive atom or group of atoms, united by oxygen to a negative atom or group of atoms.

14. *What do the terminations* **ic** *and* **ous, ate** *and* **ite** *indicate?*

Acids are named with the terminations **ic** and **ous** the same as binary compounds. The hydracids are characterized by the prefix hydro, as hydrochloric, hydrobromic, etc. Salts are named from the acid from which produced, by changing the termination, thus, from an *ic* acid is produced an *ate* salt, from an *ous* acid an *ite* salt.

15. *What is the atomic theory?*

It is believed by chemists: (1) that the atoms of the same element are exactly alike in size, form, and weight; (2) that the atoms of different elements are unlike, differing at least in weight, if not in form; (3) that equal volumes of bodies in a gaseous state at the same temperature and pressure contain an equal number of molecules.

In fixing the relative weights of atoms, hydrogen, being the lightest of known bodies, is taken as the standard, and the atom of hydrogen is considered as one,—the other elements compared with it.

16. *Illustrate atomic weight.*

The **atomic weight** represents the smallest quantity of any simple element which can enter into the formation of a chemical compound. It is the same as the specific gravity of the body in the gaseous state compared with hydrogen.

17. *Define atomicity.*

This is a term used to denote the proportion in which the atoms of elements unite with atoms of hydrogen.

The elements are arranged in seven groups and receive the names of monads, dyads, triads, tetrads, pentads, hexads, and heptads, according as they mix with 1, 2, 3, 4, 5, 6, or 7 atoms of hydrogen. The elements which have an even atomicity are called artiads, those having an odd atomicity are called perissads. Equivalence and quantivalence are terms synonymous with atomicity.

18. *What is molecular weight ?*

The **molecular weight** of a compound substance is the sum of the atomic weights of its constituents. The molecular weight of water is 18, the atomic weight of oxygen being 16 and that of hydrogen 1, and water containing two atoms of hydrogen in each molecule.

19. *Define catalysis and allotropism.*

When one substance produces an effect on another by its mere presence, the action is called **catalysis.** The capability of existing in more than one form with the chemical identity undestroyed is called **allotropism.**

20. *What are crystalline and amorphous substances, respectively ?*

When the molecules of a body arrange themselves in regular geometrical forms they are said to be **crystalline.** Substances which are not crystalline are **amorphous.**

Substances which have two crystalline forms or crystallize under two systems, are said to be **dimorphous.** Different substances which crystallize in the same form are said to be **isomorphous.**

21. *What is an auhydride ?*

An oxide of a non-metallic (or electro-negative) element, which, with the elements of water, forms an acid, is called an **auhydride.**

Thus, when carbon, a non-metal, burns in the air it unites with oxygen to form an oxide whose formula is CO_2 and which will unite with H_2O to form H_2CO_3, or carbonic acid.

22. *CO_2 is known under what names ?*

(1) **Carbonic auhydride,** because it is an auhydride; (2) **carbonic oxide,** because it is an oxide of carbon, and being highest, it takes the termination *ic*; (3) **carbon dioxide,** because an oxide

of carbon and containing two atoms of oxygen; (4) **carbonic acid gas,** because it is a gas and was formerly considered an acid.

The term *carbonic acid* when applied to CO_2 is, however, improper, as it is not an acid.

GEOLOGY.

1. *Define Geology.*

Geology is the science which treats of the *past* conditions of the *earth* and of its *inhabitants.*

It includes a discussion of progress in the development of the solid structure which makes up the earth's crust, the changes in all physical conditions, as light, heat and moisture, and the development of life as shown by the fossil remains.

2. *Meaning of rock in Geology?*

Any substance constituting a portion of the earth's crust, whether it be hard or soft, is called a *rock.* No distinction based on hardness alone is of any value.

It signifies any lifeless constituent of the earth's crust, whether of organic or inorganic origin.

3. *How are rocks classified?*

Rocks are divided, according to their structure and origin, into two principal kinds, viz., *stratified* and *unstratified.*

Stratified rocks are more or less consolidated *sediments,* and are therefore *aqueous* in origin and earthy in structure. Unstratified rocks have been more or less *fused,* and therefore are *igneous* in origin and either crystalline or glassy in structure.

4. *What is a fossil?*

Stratified rocks contain the exact *forms* of organisms, especially shells, though these seem to have *turned to stone.* These are called *fossils.*

A fossil may be defined as any evidence of the former existence of a living thing. By petrifaction is meant that stony or earthy material has taken the place of the organic matter wholly or in part, and preserved the form and structure more or less perfect.

5. *What structures are common to all kinds of rocks?*

(1) Joints; (2) great fissures; (3) mineral veins.

Joints are probably shrinkage—cracks. Fissures are fractures by crust-movements. Rocks, especially metamorphic rocks, are marked with seams and scars running in all directions, as if they had been crushed and broken and again mended ; as indeed they were.

6. *Of what is the solid portion of the earth mostly composed?*

Of quartz and silicates. Quartz, besides being another name for silica, is also applied to denote some of the varieties of silica produced by the various impurities and by differences in structure. Silica is a combination of *silicon* and *oxygen*.

7. *Under what four series may the composition of rocks be considered?*

(1) Silica; (2) Alumina; (3) Calcia; (4) Silicates.

8. *Name the most important of the varieties of silica.*

Rock Crystal, Rose Quartz, Chalcedony, smoky or limpid, Amethyst, Jasper, Flint, Hornstone, Chert, Opal, Buhrstone, and Sand.

9. *Explain rock disintegration.*

In all rock some parts are soluble in atmospheric water, and some are not. Under the long-continued action of this agent, therefore, the soluble parts are dissolved, and the mass breaks down into a powder, or dust of the insoluble parts, wet with a solution of the soluble parts.

10. *How are the varieties of rocks distinguished?*

(1) Relative hardness; (2) Specific gravity; (3) Cleavage; (4) Fusibility; (5) Action of acids; (6) Crystalline form; (7) Color and luster; (8) Chemical composition.

11. *How may rocks be classified as to manner of formation, or origin?*

(1) Sedimentary, or those which have been formed by the deposit of solid material in water, and usually in layers. (2) Igneous, those which have been thrown to the surface in a melted state, not usually in layers. (3) Metamorphic, which have been originally sedimentary but have been altered by heat and great pressure.

12. *What are the divisions of sedimentary rock?*

(1) Sandstone, simply consolidated sand; (2) Conglomerate, gravel consolidated; (3) Shale, consolidated clay with other ingredients mixed, separated into thin layers, very fragile; (4) Limestone, frequently containing many fossils.

13. *How may igneous rocks be classified?*

Igneous rocks can not be classified, like sedimentaries, by relative age. They are best classified partly by texture and partly by mode of occurrence. They thus fall into two strongly contrasted groups, viz., *plutonics* and *volcanics*, or *granitics* and *true eruptives.*

It is sometimes convenient to speak of an intermediate group—*trappean.* The granitic occur *beneath;* the trappean, injected *among;* the volcanic, outpoured *upon,* the stratified rocks.

14. *What are the most important metamorphic rocks?*

The principal kinds are Gneiss, Mica-schist, Chloride-schist, Talcose-schist, Hornblende-schist, Clay-slate, Quartzite, Marble, and Serpentine.

15. *Define the following terms: Stratum, formation, fault, concretion, geode, dip, dike, lode, vein.*

A *stratum* is a collection of layers of one kind of rock, varying in thickness from a few inches to hundreds of feet. A number of strata which were formed at the same time and having a general similarity as to fossil remains, is called a *formation.* The angle which an inclined strata makes with the horizon is called the *dip.* A *fault* is a want of correspondence in vertical cracks or fissures in rocks. *Concretions* are rounded masses of rock sometimes with layers like the coats of an onion. *Geodes* are peculiar concretions containing crystals generally of quartz. *Veins* and *dikes* are fissures in rocks which have been filled with material in a melted state. Veins filled with metallic ores are called *lodes.*

16. *How may rocks be classified as to time of formation?*

The first grand division of Geologic history are called *Times.* Times are divided again into *Ages,* ages into *Periods,* and periods into *Epochs,* epochs sometimes into *Groups.*

These are all marked by differences in animal and vegetable remains, and by difference in kinds of rocks.

17. *What are the four grand divisions of Geologic history based upon the development of life?*

The first land, *Azoic*, was without life. The next grand division is called the *Paleozoic Time*. Next in the scale is the *Mesozoic Time*. The fourth is the *Cenozoic Time*.

The rocks of the Archæan time are supposed to be the foundation of the earth's crust, underlying all others, but covered so deeply by later formations that they can not be seen except at a few points where they "crop out" and form the surface rocks.

18. *What is the oldest known form of life?*

The first life must have been vegetable, since the animal subsists upon the vegetable.

The *Eozoon Canadense* is the oldest or first form of life that has been identified by its remains. It is supposed to be an animal of the class Rhizopods of a very low order.

19. *What are the divisions of the Paleozoic Time?*

The Paleozoic Time is divided into three ages marked by characteristic forms of life. They are the Silurian, the Devonian, and the Carboniferous.

20. *Describe the Silurian Age, location, kinds of rocks and fossils.*

The Silurian Age, or age of mollusks, has for convenience been divided into the Upper Silurian and Lower Silurian, which may be considered as sub-ages. Each of these has been divided into periods. The kinds of rock are various, consisting of immense beds of limestone, sandstone, shales, marl, millstone grit, etc. Many of them are abundant in fossils, representing the sub-kingdoms, Protozoa, Radiata, Mollusca, and Articulata.

The vegetable kingdom is represented by seaweeds and some lower forms of land plants. The most interesting fossil, perhaps, is the *Trilobite*, an articulata, several species of which are found in a very perfect state of preservation.

21. *Describe the Devonian Age.*

The Devonian Age is the Age of Fishes. Limestones, sandstones, and shales principally compose the formations. Fossils of all the sub-kingdoms are found, but the age is especially noted for the number of fossil fishes. Insects first make their appearance in this age.

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22. *Describe the Carboniferous Age.*

This is the Age of Coal Plants. The rocks are mostly limestone and sandstone, with seams or beds of coal varying in thickness from that of a sheet of paper to 40 feet.

The presence of coal, with the evidence of its being of vegetable origin, and the immense number of fossil plants found, warrant us in concluding that at this stage of the earth's history vegetation flourished in much greater luxuriance than now.

23. *What is the Mesozoic Age?*

The Mesozoic Age comprises the Age of Reptiles, which is divided into three periods, Triassic, Jurassic, and Cretaceous.

The fossils of this time are characteristic and wonderful. Immense forms, half reptile and half bird, sported in the waters or flapped through the air. Birds and mammals make their appearance for the first time.

24. *What is the Cenozoic Age?*

It is divided into two ages, the Tertiary, or Age of Mammals, and the Quarternary, or Age of Man.

The strange and huge reptilian forms now give place to immense mammalian species which reach their greatest size in the Quarternary. The mastodon, mammoth, and others of that type, existed just previous to the advent of man.

SECTION VI.

ASTRONOMY.

1. *Define Astronomy.*

Astronomy is the science which treats of the sun, moon, earth, planets, comets, etc., showing their magnitudes, order and distances from one another, measuring and noting their risings, settings, motions, appearances, the dates and number of their eclipses, etc.

2. *What may be said of the progress of astronomical science?*

The study of the heavenly bodies occupied the attention of the ancients many centuries before the advent of Christ, but definite knowledge concerning them was very limited, and such may be said to be the case yet. With the introduction of the telescope, however, much information has been gained in the past three centuries.

3. *What were the conjectures of the ancients concerning the shape of the earth, etc.?*

Various were the conjectures of the ancients concerning the shape of the earth and the relations which the sun, moon, and stars held to our planet, the impression being that the earth was flat, and was the center of the universe, the various heavenly luminaries revolving around it.

4. *What was the system of Pythagoras?*

Pythagoras, Thales, and Plato conceived the idea that the world was round and that it had two movements, one being diurnal upon its axis and the other around the sun. They taught that the sun, which they thought the center of the universe, was a

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globe of fire, which lighted the moon and gave heat and light to the earth.

5. *Who prepared the first systematic work on astronomy?*

Ptolemy, who, rejecting the system of Pythagoras, announced that the earth was the center of the universe, and the heavenly bodies revolved around it. For thirteen centuries after Christ this idea possessed the inhabitants of the earth.

6. *What is the Copernican system of the universe?*

A particular system of the heavenly bodies first proposed by Copernicus, a Polish astronomer. This theory is the one now universally adopted, placing the sun in the center of the solar system, with all the other planets revolving round it in a particular and regular order.

7. *What was demonstrated by Kepler?*

Kepler, a German astronomer, about the sixteenth century, demonstrated that the planets, instead of revolving around the sun in perfect circles, made their revolutions in elliptic orbits. He also determined the dimensions of the orbits of the several planets and their velocity of movement.

8. *What were the researches of Galileo?*

His researches with his telescope resulted in a close inspection of the moon, which very clearly determined its character. The satellites revolving about Jupiter were discovered, and many facts relating to the celestial bodies were made known.

9. *What was Newton's great discovery?*

He discovered the law of gravitation, by which all the heavenly orbs are held in place.

Later, many discoveries were made by Herschel of heavenly orbs, among them being Uranus and various satellites.

10. *What is the nebular theory advanced by Laplace?*

This advances the idea that the heavens are studded with innumerable groups of planets, in the center of each of which is a sun around which a certain number of planets revolve in a manner similar to the movements of our planetary system.

The idea was further advanced that the sun once filled all the space now occupied by the orbits of the several planets. That from the sun has been thrown off from time to time an emanation of gaseous substance which formed in a ring about the sun, and in due time broke, collected together and made a planet. That the sun has gone forward gradually contracting and throwing off rings thus until all the planets in the solar system have been in this manner developed.

11. *What may be said of the system of the universe?*

That this solar system of ours, with its sun and planets revolving in space, is but one of millions of similar systems, thousands of whose planets are inhabited, while some once inhabited are dead, and others are yet too young and gaseous to admit of habitation. That while the planets revolve around the sun, this sun with its family of planets revolves around a greater sun, and this greater sun with its multitude of systems revolves around a great central sun.

12. *What definite intelligence have astronomers?*

Their intelligence of the heavenly bodies is confined to the size, revolutions, orbits, density, and conjunctions of the planets which revolve about our sun. The principal of these planets are named in their order as they go out from the sun as follows: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.

13. *What is the relative size of each of the primary or principal planets in our solar system?*

This may be judged by the following comparison presented by an astronomer, the sun being represented as a globe two feet in diameter standing in an open field: A pinhead 164 feet away will represent Mercury; a pea 284 feet from the sun, Venus; another pea 430 feet, Earth; a large pinhead 654, Mars; a medium-sized orange nearly half a mile from the globe represents Jupiter; a small orange four-fifths of a mile shows Saturn; a small plum a mile and a half represents Uranus; and an ordinary plum two miles and a half from the globe shows Neptune.

All the planets of our system together would not equal in bulk a six-hundredth part of the body of the sun.

14. *State some facts relating to the sun.*

The sun is the center of our great solar system, the source of light and heat to all other planets within this system, and an immense power in the production and maintenance of animal and

vegetable life. Of the sources of the sun's heat nothing is positively known, although it is believed that it is derived from electrical influences. The distance of the sun from the earth is 92,000,000 of miles. It has no orbit, for it is stationary, but it revolves upon its axis.

The sun is supposed to be a dark and solid globe, surrounded by two coverings of gaseous material.

15. *What may be said of the sun's spots?*

Dark spots of irregular form, rarely to be seen with the naked eye, sometimes pass over the sun's surface from east to west, within a period of nearly fourteen days.

They are supposed to be ruptures or openings in the outer fiery envelope of the sun. They usually present a dark nucleus, surrounded by a strip of shaded light, and that by a margin of light more brilliant than the sun itself.

16. *Describe Mercury.*

Mercury is the smallest of the principal planets in our solar system. It is the nearest to the sun, being 37,000,000 miles from that luminary. It performs one revolution upon its axis in 24 hr. 5 min, and 28 sec. It revolves round the sun in 88 of our days, which is the length of its year.

17. *Which is the second planet from the sun?*

Venus, the brightest star in the heavens. It is about 68,000,000 miles distant from the sun, around which it revolves from west to east in 224⅔ days. As its distance from the earth constantly varies, its apparent size and brilliancy continually change. It turns upon its axis once in 23 hr. 21 min. and 7 sec.

Venus is best known to us by her constant position either as the earth's evening star or morning star, continuing in each of these offices alternately 292 days, appearing as the former in the western horizon and as the latter in the eastern.

18. *What is the " Transit of Venus?"*

Twice in a century Venus passes between us and the sun, traversing the disk of the latter. This is called the "transit of Venus," and is considered among astronomers one of the most interesting of celestial events.

19. *Describe the earth.*

The earth is not a perfect sphere, being considerably flattened

at the poles. The revolution of the earth upon its axis is called its "diurnal motion," because it forms one entire night and day. The earth has a circumscribed pathway through space, called its orbit, over which it passes around the sun once in 365¼ days.

The earth has one satellite, or moon. On the first day of January the earth is about 3,000,000 miles nearer the sun than on the third day of July, but its surface being slantingly placed toward the sun at the former period, the heat is lessened instead of increased.

20. *Which is the fourth planet from the sun?*

Mars is the fourth planet from the snn, and the first of the "exterior planets," or those whose pathways around the sun are outside that of the earth.

Its average distance from the sun is 145,000,000 miles. It makes one complete revolution upon its axis in 24 hr. 39 min. and 2½ sec. Mars has two moons.

21. *Describe the largest of the planets.*

Jupiter, the largest of all the planets in our solar system, and one of the brightest, has an average distance from the sun of about 480,000,000 miles. Its diameter is about twelve times greater than that of the earth.

It requires almost twelve of our years to complete its circuit round the sun. It revolves upon its axis in 9 hr. and 56 min. of our time.

22. *What are the Asteroids?*

The numerous small planets whose orbits are situated between those of Mars and Jupiter; these include Astræa, Ceres, Iris, Hebe, Juno, Pallas, Vesta, and more than one hundred others.

They are supposed to be fragments cast off from other remote planets, and are held in their places by solar influences.

23. *Describe Saturn.*

The distance of Saturn from the sun is 872,132,000 miles. It requires twenty-nine and a half of our years to accomplish one of its annual circuits. It makes one revolution upon its axis in 10½ of our hours.

Saturn has eight moons and two magnificent rings, above and around its equator, encircling it with perpetual light, brighter to the observer than the planet itself.

24. *Describe Uranus.*

The distance of Uranus from the sun is 1,822,360,000 miles. It

is said to revolve upon its axis once in 7 hr. and 5 min. Its revolution around the sun occupies about eighty-four of our years.

Uranus has six moons, which, instead of revolving around it from west to east, as all other moons do around their respective planets, except in the case of Neptune, apparently move from east to west.

25. *Which is the most distant planet from the sun?*

Neptune, whose distance from the sun is 2,745,998,000. It moves once around the sun in nearly 164½ of our years.

One moon has been discovered, but astronomers insist that it is entitled to five more.

26. *Meaning of Aphelion and Perihelion, respectively?*

Aphelion is that point at which any planet is farthest from the sun. Perihelion is that point of a planet's orbit in which it is nearest to the sun.

27. *What is the Axis of the heavens?*

The axis of the earth, from north to south, or from east to west, presenting both ways to the concave surface of the heavens.

28. *What is centripetal force?   Centrifugal repulsion?*

That force which draws a body toward the sun; "centrifugal repulsion" is that power which the sun has to repel other bodies; both forces keep the planets in their places.

29. *What is a comet?*

A round, transparent body, resembling a planet, which performs irregular or eccentric revolutions about the sun in long and narrow orbits, which have the sun in one of their focuses.

It consists of a spherical, transparent light, enclosing a transparent nucleus, or ball, and a long train, or tail, of fiery particles, by which comets are distinguished from other heavenly bodies.

30. *What is the Constellation?*

An assemblage of fixed stars, imagined to represent the form of some creature or other object, such as a bear, a ship, or noted heathen god or goddess, from which they derived those names that are now used in designating and describing the stars.

31. *When does an eclipse of the sun take place?*

When the dark body of the moon, passing directly between the earth and sun, intercepts his light.

This can happen only at the instant of *new* moon, or when the moon is in conjunction, for it is only then that she passes between us and the sun.

32. *When does an eclipse of the moon take place?*

When the dark body of the earth, coming between her and the sun, intercepts his light and throws a shadow on the moon.

This can happen only at the time of full moon, or when the moon is in opposition, for it is only then that the earth is between her and the sun.

33. *What is the Ecliptic?*

A great circle of the sphere in which the sun performs his apparent annual motion; it is supposed to be drawn through the middle of the Zodiac, and makes an angle with the equinoctial of nearly 23° and 30′, which angle is called "the obliquity of the ecliptic."

34. *What is the Zodiac?*

A zone, or girdle, about 16° in breadth, extending quite around the heavens, and including all the heavenly bodies within 8° on each side of the ecliptic. It includes, also, the orbits of all the planets, except some of the asteroids.

SECTION VII.

ZOOLOGY.*

1. *Define Zoology.*

Zoology is the science which treats of animal life in general, including the classification, general characteristics and modes of life of all the species and varieties of the animal kingdom.

The sciences subordinate to Zoology are Ornithology, Icthyology, Herpetology, Entomology, etc.

2. *Upon what is a classification based?*

The entire animal kingdom is divided into **sub-kingdoms,** based upon a general common plan of structure. Each sub-kingdom is again divided into **classes,** based upon general physiological characters. Each class is divided into **orders,** orders into **families,** families into **genera.** Each genus is divided into **species,** embracing all animals which have descended from a common ancestor.

Species are sometimes divided into **varieties** based upon certain points of resemblance.

3. *How are varieties produced?*

Animals which have been domesticated are inclined to vary, and these variations have been strengthened by selecting the more marked varieties and breeding from them exclusively, and also by crossing varieties until well marked and permanent varieties are produced.

Among the lower domestic animals the term *breed* is in common use as synonymous with variety. The varieties of men are called *races.* A cross between two varieties is called a *mongrel*, between two species a *hybrid*.

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*The matter of this Section was compiled from "LIND'S TEACHERS' AND STUDENTS' LIBRARY."

4. *Name the points distinguishing animals from plants.*

Animals are generally characterized by: (1) Powers of loco-motion. (2) Sensation. (3) The animal has generally a fore-and-aft structure as a distinction from the plant, which has generally an up-and-down structure. (4) The food of animals is generally organic, that is, plants or other animals. (5) The food is prepared for assimilation in a digestive cavity, or stomach. (6) They inhale oxygen and exhale carbonic oxide.

5. *What is a vertebrate animal?*

Vertebrata includes the most highly organized animals and those which have general characters, as follows: (1) A bony frame-work, or skeleton, which forms the axis of the body, and upon which the softer parts are arranged, this axis being made up of joints or vertebræ, whence the name. (2) The nervous system consists of a brain, spinal cord, ganglia, and nerves. (3) The blood is red. (4) A transverse section of the body exhibits two cavities, one in the spinal column containing the spinal cord, the other formed by the ribs and softer parts, and containing the organs of digestion and respiration. (5) They never have more than two pairs of limbs. (6) They breathe through the mouth. (7) The mouth opens transversely to the axis of the body.

6. *Define Mammalia.*

The **Mammalia** are the highest division of the vertebrata, and are characterized as follows: (1) Nourish their young by milk secreted by the mammary glands of the mother, whence the name. (2) Viviparous, bring forth their young alive. (3) Generally, but not always, covered with hair; never covered with feathers. (4) Warm blooded, the temperature being about 98° F. (5) Heart has four chambers, two auricles and two ventricles, there being a complete double circulation, *i. e.* from the body to the heart, from the heart to the lungs for purification, and back again to the heart to be again sent to the body. (6) They have a complete diaphragm. (7) Two occipital condyles, and (8) the lower jaw is articulated directly with the skull.

7. *To what order does man belong?*

The characteristics which distinguish **man** (Binana) from the other mammalia are: (1) An erect position. (2) Progression

on two legs. (3) Can oppose the thumb to the fingers in the hands, but not in the feet. (4) He is plantigrade, or the bones of the tarsus, metatarsus, and phalanges form the foot and come on a level. (5) Has 32 teeth—2 incisors, 1 canine, 2 bicuspeds, and 3 molars in each side of each jaw. (6) The brain is much larger in proportion to the body than any other animal, and his mental powers are capable of great development. (7) The only terrestrial mammal not generally covered with hair.

8. *What order next to man in development?*

The order **Quadrumana,** characterized as follows: (1) By having the great toe of the foot opposable to the other toes. (2) They are covered more or less with hair. (3) In mode of life they are arboreal and terrestrial, and generally frugiverous. (4) Do not assume the erect posture as a habit. (5) Their imitative qualities are largely developed. (6) The spinal opening in the skull is in the posterior third of the base, the thumb is very short, the pelvis long and narrow, the vertebral column has but a single curve, the arms are relatively very long and the canine teeth prominent. They embrace the three families of monkeys.

9. *Describe the Order Carnivora (to which the dog belongs).*

(1) Chiefly flesh eating. (2) Canine teeth largely developed, molars adapted for cutting. (3) Feet with well developed claws, retractile or non-retractile. (4) Skull comparatively small with high occipital crest. (5) Clavicles rudimentary or wanting, humerus and femur mainly enclosed in the body. (6) All covered with hair, many furnish valuable furs.

They are divided into eleven families: *Felidæ*, cat; *Viverida*, civet; *Hyenidæ*, hyena; *Canidæ*, dog; *Mustelidæ*, weasel; *Ursidæ*, bear; *Procyonidæ*, raccoon; *Bassaridæ*, civet cat; *Otaridæ*, eared seal; *Phocidæ*, seal; *Rosmaridæ*, walrus.

10. *Describe the Order Ungulata (to which the horse belongs).*

(1) By having hoofs, digitigrade, that is phalanges only touching ground in walking. (2) Molar teeth with grinding surfaces, no tusks, and chiefly herbivorous. (3) Clavicles wanting, radius and ulna united, brain convoluted as in all animals higher in the scale. (4) Many are ruminants.

They are divided into eleven families, as follows: *Camelidæ*, camel; *Giraffidæ*, giraffe; *Bovidæ*, ox; *Antilocapridæ*, prong-horn antelope; *Cervidæ*,

deer; *Hippopotamidæ*, hippopotamus; *Suidæ*, hog; *Dicotylidæ*, peccary; *Equidæ*, horse; *Rhinocerolidæ*, rhinoceros; *Tapiridæ*, tapir.

11. *Describe the Order Proboscidæ (to which the elephant belongs).*

Two species of elephant, the *Elephas Indicus* and *Eliphas Africanus*, are the only living representatives of this order. The humerus and femur are elongated and the heel brought nearer the ground than in the horse and ox. The clavicles are wanting, and the neck is too short to enable it to take its food from the ground with its mouth. The trunk which is a prolongation of the nose contains several thousand muscles, and is useful in procuring food and conveying it to the animal's mouth.

12. *Describe the order to which the whale belongs.*

The order **Cetacea** includes whales, the porpoise, and the dolphin. They are characterized by naked bodies, no clavicles, no hind limbs, tail, a horizontal fin, nostrils on top of the head.

> *Whalebone* comes from the Greenland whale, and is not bone but slabs of horn-like material sometimes ten feet in length, hanging from the upper jaw, and serves to strain out the minute animals on which it feeds. The sperm whale has an immense cavity in the head containing an oil which hardens and forms the *spermaceti* of commerce. *Ambergris* is a peculiar product used in making perfumery and is found in the intestines of the sperm whale.

13. *Of what order is the bat a representative?*

Of the order **Cheiroptera.** They are true flying mammals. They are characterized : (1) By having the exterior limbs adapted for flight; the ulna and radius united; the bones of the hand and fingers greatly elongated, supporting a leathery skin which extends to the posterior limbs. (2) The clavicles are long, the skeleton light. (3) The touch is acute, and they are nocturnal and chiefly insectivorous.

14. *What is the smallest mammal?*

The order **Insectivora,** characterized as follows: (1) The limbs adapted for walking, plantigrade. (2) Teeth with sharp points adapted for crushing insects. (3) The cerebrum not convoluted. (4) Mostly small in size, the shrew being the smallest of mammals, and many are subterranean in their habits. It includes the mole, hedgehog, and shrew.

15. *What is the order Rodentia?*

They are characterized : (1) By lack of canine teeth, and in-cisors chisel-shaped, adapted for gnawing, whence the name.   (2) Clavicles in nearly all ; cerebrum nearly smooth.

The mouse and rat, squirrel, beaver, gopher, porcupine, Guinea pig, and rabbit are members of this order.

16. *Describe the Edentata.*

They are destitute of incisors, which is about the only general characteristic.   This order includes the sloth, the armadillo, and the ant-eater.

17. *What is the character of the lowest orders of mammalia?*

The two lowest orders are the **Marsupialia** and the **Monotre-mata.** They approach the structure of birds.   The Marsupialia, which includes the kangaroo and the opossum, are characterized by having the young brought forth in an immature state and car-ried sometimes in a pouch in the abdomen of the mother.   The Monotremata are characterized by having but one external open-ing for the intestinal canal and bladder, the same as birds.

The porcupine, ant-eater, and the duck-bill, or water-mole are representatives.

18. *Give the characteristics of birds.*

They are of the class **Aves,** and are the only animals clothed with feathers.   They are further characterized as follows: (1) The inferior maxillary bone articulates with the skull through a separate bone.   (2) One occipital condyle enabling the bird to turn its face completely backward.   (3) Four, anterior for flying, posterior for walking.   (4) Femur short, knee never seen outside of plumage—first joint visible being the heel.   (5) Toes ending in claws, generally four in number.   (6) No diaphragm, epiglottis or teeth.   (7) Cerebrum smooth, cerebellum single lobed.   (8) Eyes with three lids.   (9) One opening for excretion of kidneys and alimentary canal.   (10) The bones are light, containing a large proportion of phosphate of lime and the marrow in many cases replaced by air, which communicates with the lungs.   (11) The clavicles are usually united, forming the " wish-bone."   (12) The

temperature is much higher than in mammals. (13) The young are produced from eggs which are hatched outside the body.

19. *Give a representative of each order of birds.*

(1) **Passeras,** the sparrow, bluebird, mocking-bird, robin, swallow, lark, crow, jay, bird of Paradise, lyre, weaver, and many of the common birds of this country. (2) **Picaræ** includes the woodpecker, kingfisher, whip-poor-will, cuckoo, humming-bird, etc. (3) **Psittaci,** the parrots, cockatoos, etc. (4) **Raptores,** or birds of prey, including hawks, eagles, owls, falcons, condors, and vultures. (5) **Columbæ** includes pigeons and doves. (6) **Gallinæ,** which includes domestic fowls, pheasants, quails, etc. (7) **Brevipennes,** the ostrich and apteryx. (8) **Linicolæ,** birds with long beaks, as snipes. (9) **Herodiones,** herons, storks. (10) **Alectorides,** the whooping crane, rails, etc. (11) **Lamellirostres,** geese, ducks, etc. (12) **Steganopodes,** the pelican, cormorant, etc. (13) **Longipennes,** sea gulls, albatross, etc. (14) **Pygopodes,** the loon, etc. (15) **Sphenisci,** the penguin.

20. *Describe reptiles.*

The class **Reptilia** are characterized as follows: (1) Air-breathing, but cold blooded. (2) With horny scales or bony plates. (3) Skeleton is never cartilaginous, and the skull has but one occipital condyle; the vertebræ usually concave in front. (4) Teeth in all except turtles, and not fastened in sockets except in crocodiles. (5) The heart has three chambers, except in crocodiles, which have the ventricle partitioned; the venous and the arterial blood are mixed. (6) Nearly all carnivorous. (7) Reproduced from eggs, which are generally hatched without the body.

21. *Give a representative of each order of reptiles.*

(1) **Testudinata,** or turtles. (2) **Loricata,** the alligator and crocodile. (3) **Lacertilia,** or lizards, including also the chameleon, the horned frog, the glass snake, etc. (4) **Ophides,** or snakes.

22. *Describe the class Pisces, or fishes.*

They are the lowest of the vertebrates. The eyes are almost immovable, and are unprotected by lids. Though having ears,

yet sound is passed through the cranium. This class includes nearly one-half of all the vertebrated species.

23. *Describe the class Amphibia.*

They are distinguished by (1) Having a double life, that is in the immature or tadpole state, breathing by means of gills as fish, and in the mature state by lungs. (2) The heart has three chambers, two auricles and one ventricle; cold blooded. (3) They are covered with a naked skin. This class includes frogs, toads, salamanders, etc.

24. *What are invertebrates?*

All animals not belonging to the sub-kingdom vertebrata are sometimes called **invertebrates.**

25. *Descvibe the Articulates.*

The **Articulata**—largest of all the sub-kingdoms—comprises four-fifths of the animal world. They are characterized as follows: (1) Body composed of rings, or ring-like plates more or less indurated and enclosing the vital parts. (2) The nervous system mainly a double chain of ganglia on the ventral side of the body. (3) Alimentary canal, a nearly straight tube lying lengthwise in the center of the body. (4) The circulatory organs, nearly straight tubes running along the back. (5) The respiratory organs, a system of tubes throughout the body communicating externally with the air in various places. (6) Blood white, except in some of the worms. (7) A transverse section of the body shows but one cavity. (8) The mouth opens vertically with the axis of the body, and the number of limbs varies from none at all to fifty or more pairs.

26. *Why does a fly or bee not die instantly when the head is cut off or the body cut in two?*

Because the nervous system is so constructed that each segment represents a nearly complete animal.

27. *Describe insects.*

The class **Insecta** is characterized as follows: (1) Body divided into three distinct sections, head, thorax, and abdomen. (2) Three pairs of jointed legs, one pair of antennæ, or feelers, and

usually two pairs of wings, the legs and wings borne on the thorax. (3) The eyes are usually compound, being made up of hexagonal cones, sometimes many thousand in number, but each a distinct eye. (4) Many undergo a *metamorphosis*. When first hatched from the egg the insect is called a *larva* which, if it be without legs, is called a grub or maggot ; if with legs, a caterpillar ; and when its full size is reached it sheds its coat and remains for a time dormant, then called the *pupa*, which is sometimes surrounded by a *cocoon* spun and woven of silk by the larva. After remaining a certain time in the pupa state it bursts its covering and emerges an *imago* or perfect insect.

28. *What does the class Myreapoda include ?*

Centipedes, earwigs, etc., and are characterized by having the thorax and abdomen merged in one, but the head distinct. They have usually many legs, as the name indicates, and their bodies are worm-like in appearance.

29. *Describe the class Arachnida.*

They have the head and thorax merged into one, and the abdomen distinct, and four pairs of legs, with from two to eight simple eyes. The spiders, scorpions, and the itch mite belong to this class.

30. *Describe the class Crustacea.*

This includes the largest and strongest of the sub-kingdom. All are aquatic and breathe by gills. Their bodies are covered with a hard crust, whence the name. The shell is frequently cast, as the animal grows too large for it. When a limb is lost by accident another grows in its place. The crawfish, crabs, and the lobster belong to this class.

31. *Describe the class Annelida.*

It includes all animals known as worms, such as the common earth-worms, leeches, the tape-worm, etc.

32. *What are Mollusca ?*

(1) Soft bodies without joints or internal skeleton, covered with a contractile skin, or mantle. (2) Sometimes the skin is naked,

but usually covered with a shell of calcareous material. (3) The nervous system consists of three pairs of ganglia around the neck, or entrance to the alimentary canal, with other ganglia scattered throughout the body. (4) The majority are water breathers and exist in the ocean. Snails, oysters, and mussels are common types of this sub-kingdom.

33. *Give a representative of each class of mollusks.*

(1) **Cephalopoda;** to this class belong the cuttle-fish, which has the power of ejecting a black fluid, which darkens the water and screens it from pursuit. It has a spongy, calcareous mass within its body, known as cuttle-fish bone, and used for canary birds. The devil-fish and the nautilus also belong to this class. (2) **Gasteropoda,** which move by a fleshy disc called the foot, and usually covered with a spiral univalve shell. The common snail is typical. (3) **Lamelli-Branchiata,** which have bivalve shells, the oyster and mussel being typical. (4) **Brachtipoda,** which have arms coiled up within the shell, a bivalve, being symmetrical, *i. e.* equal on each side of the hinge. (5) **Tunicata,** which appear as a gelatinous mass covered with two tunics or coats, forming a tube through which the water passes. (6) **Polyza,** —compound animals,—the individuals inhabiting separate cells, but attached to each other and resembling a plant.

34. *Describe the Echinodermata.*

They have all the parts arranged around a central axis in fives or multiples of five. It includes classes named and represented as follows: (1) **Holothuridæ,** sea slugs; (2) **Echinoidea,** sea urchins; (3) **Asteroidea,** star-fish; (4) **Crinoidea,** crinoids, or sea lilies.

35. *Describe the Cœlenterata.*

They are animals radiated in structure, but having a distinct cavity in the body with walls of two layers of cellular tissue. They are represented by the corals and jelly fishes.

36. *Describe the Protozoa.*

This includes all the lowest forms of animals that have not been classed with the other sub-kingdoms. They are all small, living mostly in the water, and many are microscopic. They have

no distinct organs of circulation, digestion, etc., that have yet
been discovered, although they take food, grow and multiply, and
many are exceedingly active.

37. *What are Radiates?*

The sub-kingdoms Echinodermata and Cœlenterata were for-
merly included in the sub-kingdoms **Radiata.**

SECTION VIII.

PHYSIOLOGY AND HYGIENE.

1. *Define Anatomy, Physiology, Hygiene.*

Anatomy treats of the *structure* of the animal body. When applied to man it is called Human Anatomy; when applied to the lower animals, Comparative Anatomy.

Physiology treats of the *functions* of the various organs.

Hygiene treats of the *preservation* of the body in a state of health.

2. *How are the bones classified?*

There are about **200 distinct bones** in the human skeleton, divided into bones of the **head, trunk,** and **extremities.** As to form, they may be classed as *long, short, flat,* and *irregular.*

The long bones are found in the limbs. They are chiefly concerned in locomotion and act as levers. They consist of a shaft of a nearly cylindrical form, and two extremities, or heads. The short bones are those which are grouped together and united by ligaments for compactness and strength, and at the same time allowing a slight degree of motion, such as the bones of the waist and ankle. The flat bones are those which are for protection to internal organs or for the extensive attachment of muscles. The irregular bones are such as can not be classed with any of the others.

3. *What terms are used in describing bones?*

Diaphysis, the main part of a long bone; **apophysis,** a portion of a bone which projects prominently but which has never been separate from or movable upon the main bone; **epiphysis,** a portion which has been developed as a separate piece and afterward joined to the main bone.

Tuberosities are broad, uneven elevations; *tubercles* are small, rough projections; *spines* are sharp, slender projections; *ridges, lines,* are narrow, rough, extended elevations. *Fossæ, groves, fissures,* etc., denote depressions. The use of the depressions and elevations is to increase the extent of surface for the attachment of muscles and ligaments.

4. *How may the bones of the head be divided?*

The bones of the head are divided into those of the **cranium, face,** and **ear.**

5. *Name and locate the bones of the cranium.*

The **cranium** consists of 8 bones which are joined together in such a manner as to form a kind of box enclosing the brain. They are as follows; (1) The *occipital,* forming the back and lower part of the head, resting on the spinal column and perforated with a large opening called the *foramen magnum* for the entrance of the spinal marrow; (2) the *parietals,* two in number, forming the sides of the head; (3) the *frontal,* forming the forehead and brows; (4) the *temporals,* one on each side, forming the lower part of the side of the head; (5) the *sphenoid,* forming the lower part of the base of the skull, articulating with all the other bones of the cranium and holding them together; (6) the *ethmoid,* a light, spongy bone at the anterior part of the base of the skull between the orbits of the eyes.

6. *Name and locate the bones of the face.*

The **face** contains 14 bones which form attachments for the softer parts. They are: (1) the two *nasal,* forming the bridge of the nose; (2) two *superior maxillary,* or upper jaw bones; (3) one *inferior maxillary,* or lower jaw bone; (4) two *molar,* or cheek bones; (5) two *lachrymal,* very small bones at the inner corner of the orbits; (6) two *palate,* forming part of the roof of the mouth; (7) two *inferior turbinated,* scroll-like projections from the superior maxillary in the nasal fossæ; (8) one *vomer,* separating the divisions of the nasal fossæ.

The bones of the **ear** are very minute, three in number,—the *mallus, incus,* and *stapes,*—situated in a cavity of the petrous portion of the temporal bone

7. *How is the trunk divided?*

The **trunk** may be divided into the *thorax,* the *spinal column,* and the *pelvis.* The *thorax* includes: (1) the *ribs,* 24 in number arranged in pairs, joined to the *sternum* in front and to the spinal column at the other extremity, the first seven pairs being united to the sternum directly by means of separate cartilages, and called *true ribs,* the next three pairs being indirectly united to the ster-

num, called *false ribs,* the last two pairs not united to the sternum and called *floating ribs;* (2) the *sternum,* or breast bone, in the adult divided into three portions, the *manubrium,* the *gladiolus,* and the *ensiform appendage;* (3) the *clavicle,* or collar bone acting as a kind of brace and extending from the sternum to the scapula, being more frequently broken than any other bone in the body.

8. *Describe the spinal column.*

The **spinal column** consists of 24 irregular bones called *vertebræ.* In general, each vertebra consists of a body and a posterior arch which is composed of two laminæ and two pedicles with seven processes, four *articular,* two *transverse,* and one *spinous.* Between the arch and the body is a foramen, or opening, which, when all the vertebræ are put together, form the spinal canal containing the spinal cord.

They are divided into the *cervical, dorsal,* and *lumbar* regions. There are seven cervical vertebræ, the first articulating with the occipital bone is called the *atlas;* the second, which forms the pivot on which the head turns, is called the *axis;* the seventh is called the *vertebra prominens.*

9. *Name and locate the bones of the pelvis.*

The **pelvis** consists of the *sacrum,* the *coccyx,* and the two *innominata.* The sacrum consists of five solidly united vertebræ, and is in reality a continuation of the spinal column. The innominata, or hip bones, are very irregular, expanded bones, which afford attachment to the femur. The cavity which receives the head of the femur is called the *acetabulum.*

The *sacrum* is so called because it was anciently offered in sacrifice.

10. *Name and locate the bones of the upper extremities.*

The **upper extremities** consist of 60 bones as follows: (1) The *humerus,* or long bone of the arm; (2) the *ulna* and *radius,* the bones of the forearm; (3) the *carpus,* or wrist, has 8 bones arranged in two rows; (4) the *metacarpus,* or hand, consists of 5 bones articulating with the carpus above and the bones of the fingers and thumb below; the bones of the fingers and thumb, called *phalanges,* are 14 in number, three to each finger and two to the thumb.

11. *Describe the bones of the lower extremities.*

The **lower extremities** consist of 60 bones as follows: (1) The *femur,* or thigh bone, the longest bone in the body; (2) the *tibia*

(shin bone), the largest bone of the leg; (3) the *fibula*, the smallest bone of the leg, acting as a kind of brace to the tibia; (4) the *patella*, or knee-cap, is in the shape of a chestnut, and lies over the heads of the femur and tibia, held in place by strong ligaments; (5) the *tarsus*, or ankle, consists of 7 bones; (6) the *metatarsus*, or foot, 5 bones; (7) the *phalanges*, or toes, 14 bones.

12. *What bone is in the shape of the letter U, and what is its use?*

The *os hyoides*, or hyoid bone, has no articulations with any other bones. It is located just above the larynx, supports the tongue and gives attachment to many muscles. It is in the shape of the letter U.

13. *What are sesamoid bones?*

Sesamoid bones are small rounded masses of a cartilaginous nature until adult life, and are found in tendons which exert great pressure upon parts over which they glide.

The patella is really a sesamoid bone. Others are very small and are found mostly in male individuals of active muscular habit, in the region of the thumb, great toe, and sometimes in other parts of the hand and foot.

14. *What are the ligaments?*

Ligaments are bundles of white fibrous or yellow elastic tissue, pliable and elastic, which are connected with nearly all movable joints and hold the bones in place, yet allow freedom of movement.

15. *What are synovial membranes, and what do they enclose?*

Synovial membranes are delicate membranous tissues in the form of short, wide tubes attached by the open ends to the edges of the extremities of bones in the joints. They enclose a fluid, *synovia*, for the lubrication of the joints.

Bursæ are little sacs containing a viscid fluid and are found in the neighborhood of joints. Their use is to lessen friction of the moving parts.

16. *Describe the mechanical structure of bone.*

All bones are covered except at their cartilaginous extremities with a *periosteum*, which is a thin membrane intimately connected with the bone and containing nutrient vessels for the nourishment of the bone beneath. The *marrow*, or *medulla*, found especially in the cavities of long bones, consists mostly of fat. Bone is made

up of two kinds of tissue visible to the eye, *cancellous*, or spongy, and *compact* tissues, the compact being found on the exterior and cancellous on the interior.

17. *Describe the microscopic structure of bone.*

The bone substance (*matrix*) seems to be arranged in layers (*lamellæ*) around certain channels which in a cross section appear as round and oval openings. In the midst of these lamellæ are numerous little openings, or cells, arranged in rows around the larger openings, which are called *Haversian canals*. From the *lacunæ*, branching in every direction, are little channels called *canaliculi*.

18. *Describe the chemical structure of bone.*

The **composition** of the bones at maturity is about one part animal to two parts mineral matter. The proportion varies with the age. In youth it is nearly half and half, while in old age the mineral is greatly in excess.

By soaking a bone in weak muriate acid, and thus dissolving the mineral matter, its shape will not change, but its stiffness will disappear, leaving a tough, gristly substance (cartilage), which can be bent like rubber. Mix a wineglass of muriatic acid with a pint of water and place in it a sheep's rib. In a day or two it will be so soft that it can be tied in a knot. If the bone be burned in the fire, thus consuming the animal matter, the shape will still be the same, but it will have lost its tenacity, and the beautiful, pure-white residue may be crumbled into powder with the fingers:

By chemical analysis the composition of bone is as follows:

Organic substance.	33.00
Phosphate of lime	57.00
Carbonate of lime.	8.00
Fluorid of calcium	1.00
Phosphate of magnesia.	1.00
	100:00

19. *How is bone produced?*

Bone is produced by a kind of petrifaction of cartilage, *i. e.*, all bone is first in a soft condition, but develops into solid bone by deposit of earthy matter. This process is called *ossification*.

20. *What cause the motions of the body?*

The motions of the body are caused by the contraction of bundles of fibers called *muscles*.

There are over 500 muscles in the body. They are connected with the bones, cartilages, ligaments, and skin, directly or by means of *tendons* (fibrous cords), and covered with thin membranes called *fascia*.

21. *What are the forms of muscles?*

As to **form** muscles may be: (1) *Radiated*, fibers diverging from a point like a fan; (2) *penniform*, converging to one side of a tendon like a feather; (3) *bipenniform*, converging to both sides of a tendon; (4) *fusiform*, when the fibers converge to both ends; (5) *sphincter*, when the fibers run round in a circle.

22. *What are the kinds of muscles?*

As to the mode of **action,** they are: (1) *Extensors*, those which straighten a part from a bent position; (2) *flexors*, the opposite of extensors; (3) *abductors*, those which move a limb away from the body; (4) *adductors*, the opposite of abductors; (5) *pronators*, those which turn or roll a part over so that it lies on its face, as the hand turned so as to lie with the palm downward; (6) *supinators*, the opposite of pronators; (7) *sphincters*, those which act like a draw-string to close an opening.

As to **position,** they may be *superficial* (near the surface) or *deep seated*. As to **volition,** they are voluntary, involuntary, or mixed. As to **structure,** the voluntary muscles are striped, or *striated*, and the involuntary ones generally unstriped.

In describing a muscle it is customary to give: (1) Its *origin*, the more fixed or central attachment toward which the force of the muscles is exerted; (2) its *insertion*, the more movable point upon which the force is exerted; (3) *relations*, stating what other organs or parts lie in the immediate neighborhood; (4) *actions*, or use.

23. *How are muscles named?*

Muscles are named: (1) From their form, as *Deltoid*, *Rhomboidens;* (2) from their location, as *Tibialis*, *Ulnaris;* (3) from their attachments, as *Sterno-cleido-mastoid;* (4) from their use, as *Flexors*, *Extensors;* (5) from number of divisions, as *Biceps*, *Triceps*.

24. *What is the mechanical construction of muscles?*

In mechanical structure striped muscles, which comprise all the ordinary muscles of the trunk and limbs, are made up of a vast number of small cylindrical *fibers* arranged parallel to each other and bound together in little bundles by connective tissue. These bundles are united into still larger bundles and these again into one whole by connective tissue which usually thickens at one or both ends to form the tendon.

25. *What are the general divisions of the Digestive System?*

The **Digestive System** consists of the *Alimentary Canal* and *Accessory Organs.* The former consists of the mouth, pharynx, esophagus, stomach, and intestines. The latter embrace the teeth, salivary glands, liver, pancreas, and spleen.

By means of the *teeth, tongue, cheeks,* and the action of the *saliva* food is *masticated* and prepared in the mouth for the further action in the stomach. The **pharynx** is a short, irregular tubular cavity into which the mouth opens behind, serving as a portion of the canal from the mouth to the stomach. It also communicates with both ears, with the nostrils and lungs, by passages which open directly into it. The **esophagus,** or throat, is a long and narrow tube, made up of two muscular coats, which terminates in the stomach by the cardiac orifice. It contains a great number of minute glands, which secrete an oily fluid when the food is passing through it.

26. *Describe the stomach.*

The **stomach,** the most important organ in the body, is a pear-shaped sac, or enlargement of the alimentary canal, where the food is dissolved and reduced to *chyme.* It varies in size, averaging when moderately full, twelve inches in length (transversely), and four inches in breadth (vertically).

The left extremity is the larger, and is called the *greater,* or *splenic* end. The entrance of the esophagus is called the *cardiac orifice.* The opposite extremity, or where the digested food passes into the intestine, is called the *pyloric orifice.*

27. *Name the coats of the stomach.*

The walls of the stomach are composed of three **coats**—the *serous,* or outer; the *muscular,* or middle; the *mucous,* or inner.

In the middle, or muscular, coat the fibers run at right angles to each other, in order that they may contract in the most efficient manner upon the contents of the stomach for the purpose of digestion, and forcing the contents onward into the duodenum. They also assist in forcing the contents of the stomach backward in vomiting. In the inner, or mucous, lining are situated an immense number of tubular glands which open directly into the stomach.

28. *What are the intestines?*

The **intestines** are the continuation of the stomach. They form a long, narrow tube, which, like the stomach, is composed of membranous, muscular, and mucous coats. They are divided into two parts, viz., the *small intestine* and the *large intestine.*

29. *Describe the smaller intestine.*

The **duodenum** is the first division of the small intestine which

receives the contents of the stomach and effects further changes upon the food. It is 8 or 10 inches in length.

The **jejunum,** the second division of the small intestine, is about seven feet in length, and together with the **ileum,** the third division, lies coiled chiefly in the central part of the cavity of the abdomen. The ileum is about twelve feet in length and somewhat smaller in diameter than the jejunum.

30. *Describe the larger intestine.*

The **larger intestine** is about 5 feet in length and is divided into the *cœcum,* the *colon,* and the *rectum.* The cœcum is the commencement of the large intestine. The ileum opens into the large intestine at the junction of the cœcum with the colon. The colon is divided into three parts, the *ascending, transverse,* and *descending* portions. The terminal part of the large intestine and the alimentary canal is the rectum.

31. *Classify and describe the teeth.*

The **teeth** are thirty-two in all—there being eight in each half jaw, similarly shaped and arranged. In each set of eight, the two nearest the middle of the jaw have wide, sharp, chisel-like edges, fit for cutting, and hence are called *incisors.* The next corresponds to the great tearing or holding tooth of the dog, and is styled the *canine,* or eye-tooth. The next two have broader crowns, with two points in cusps, and are hence termed the *bicuspeds.* The remaining three are much broader, and as they are used to crush the food, are called the *grinders* or *molars.*

32. *What are temporary, or milk-teeth?*

We are provided with two sets of teeth. The first, or milk-teeth, are only twenty in number, 4 incisors, 2 canine, and 4 molars in each jaw. The roots of the temporary teeth become absorbed and the crowns drop out as the permanent set push up.

The middle incisors are usually cut about the age of seven months, the others at nine months, the first molars at twelve months, the canines at eighteen months, and the remaining molars at two or three years of age.

33. *What are permanent teeth?*

At six years, when the first set are usually still perfect, the jaws contain the crowns of all the second, except the wisdom-teeth. About this age, to meet the wants of the growing body, the crowns of the permanent set begin to press against the roots

of the milk-teeth, which, becoming absorbed, leave the loosened teeth to drop out, while the new ones rise and occupy their places.

The central incisors appear at about seven years of age, the others at eight; the first bicuspeds at nine, the second at ten, the canines at eleven or twelve; the second molars at twelve or thirteen, and the last, or wisdom-teeth, are sometimes delayed until the twenty-second year, or even later.

34. *What is the structure of the teeth?*

The *interior* of the tooth consists principally of *dentine*, a dense substance resembling bone. The *crown* of the tooth, which is exposed to wear, is protected by a sheath of *enamel*. This is a hard, glistening, white substance, containing only two and a half per cent. of animal matter. The *fang* is covered by a thin layer of true bone (*cement*). At the center of the tooth is a cavity filled with a soft, reddish-white, pulpy substance full of blood-vessels and nerves.

35. *How are the teeth set into the jaw?*

The socket is lined with a membrane which forms a soft cushion. While this is in a healthy state, it deadens the force of any shock, but when inflamed, becomes the seat of excruciating pain.

36. *What causes the decay of the teeth?*

It is commonly caused (1) by portions of the food which become entangled between them, and on account of the heat and moisture, quickly decompose. Also (2), as the saliva evaporates, it leaves on the teeth a sediment, which we call *tartar*. This collects the organic matter, which rapidly changes, and also affords a soil in which a sort of fungus speedily springs up.

37. *How may the teeth be preserved?*

Four rules may be laid down, the observance of which will tend to the **preservation** of the teeth: (1) Avoid extremely hot food or drink. (2) Avoid extremely cold food or drink. (3) Avoid sweet food. (4) Avoid sour food. The teeth should be brushed every morning with tepid water, and twice a week with soap and powdered orris-root.

The enamel once injured is never restored, and the whole interior of the tooth is exposed to decay. We should not, therefore, crack hard nuts, bite thread, use metal tooth picks, gritty tooth powders, or any acid that "sets the teeth on edge."

38. *Describe the Salivary Glands.*

The saliva, with which the food is moistened in mastication, is furnished by a set of bodies called **salivary glands,** whose office it is to separate this fluid from the blood. The salivary glands are three in number on each side. The largest of these, called the *parotid* gland, is situated behind the angle of the lower jaw, and forward of the external ear. It sends its saliva into the mouth through a tube or duct which opens opposite the second molar tooth, in the upper jaw. The second pair, the *submaxillary* glands are located on the inner side of the lower jaw, a little forward of the angle, on each side. The *sublingual* glands are placed beneath the mucous membrane, forming the floor of the mouth, on each side, near the base of the tongue.

The *saliva* secreted by these glands is a clear, somewhat viscid fluid, of an alkaline reaction, and consisting mostly of water.

39. *Give the location and structure of the liver.*

The **liver,** the largest glandular organ in the body, is located mostly in the right side of the abdomen, just below the *diaphragm.* In structure the liver consists of a mass of *lobules* held together by areolar tissue, among which ramify the *portal vein,* the *hepatic duct, hepatic veins, hepatic artery,* lymphatics and nerves.

The bile is a clear, yellowish, somewhat tenacious fluid, neutral in re-action and composed of about 97 per cent. water, with certain characteris-tic ingredients, *biliary salts* and several mineral salts.

40. *What is the pancreas ?*

The **pancreas** is a long, flattened gland, located behind the stomach. It is similar in structure to the salivary glands. It secretes the pancreatic fluid, which is almost identical with saliva, and is emptied into the duodenum through the pancreatic duct.

41. *What is the spleen ?*

The **spleen,** located to the left of the stomach, is classified as a ductless, or blood gland. It has arteries, veins, and lymphatics, but no excretory duct.

The function of the spleen is not well determined but it is thought that it acts as a kind of reservoir for surplus blood during digestion, and that it effects some changes in the nature of the blood.

42. *What are the processes in digestion ?*

Mastication and **insalivation.** The food is between the jaws

by the action of the tongue and cheeks, and being moistened by the saliva is by the grinding action of the teeth reduced to a pulp which is now ready for deglutition, or swallowing. It then passes into the pharynx and is prevented from going into the *larynx* by the *epiglottis* over which it glides into the esophagus, which by the alternate relaxation and contraction of its circular muscular fibers forces it on to the stomach, where it comes in contact with the gastric juice, which dissolves the albuminous portions of the food. The muscles of the stomach keep up a kind of churning action which thoroughly mixes the food and permits the gastric juice to come in contact with every part of it. This process is continued until the food is converted into **chyme,** which then passes into the small intestines, where it receives the bile and pancreatic fluid, also the intestinal juices from the intestinal glands, and it is converted into a milky white fluid called *chyle*. This is taken up by the *lacteals* and passed into the blood, and thus reaches every part of the system where nourishment is needed.

The waste portions pass along the intestines and are excreted from the body.

43. *What is the effect of the saliva?*

The effect of the **saliva** is mainly to change the starch of the food into sugar. This change takes place partly in the mouth but is continued in the stomach. Besides moistening the food and thus aiding in mastication and deglutition, it is an aid to taste, for substances to have a flavor must be in a state of solution. It also keeps the interior of the mouth moist and prevents the disagreeable sensation of dryness.

44. *What is the function of the bile in digestion?*

The **bile,** though primarily an excretion, or waste material, seems to effect some changes in the food, especially on the fatty material, preparing it for absorption by the lacteals. The pancreatic fluid has an action similar to the saliva converting starch into sugar.

The bile is of a dark, golden color and bitter taste. About three pounds are secreted per day. When not needed for digestion it is stored in the gall-bladder.

45. *Why is a variety of food essential?*

Variety is essential, as an exclusive use of easily digestible food

will weaken the organs from want of proper exercise, and an exclusive use of food difficult of digestion will overwork the organs.

46. *How should the amount of food vary?*

(1) With *age*, persons while growing need more food than at other times; (2) *temperature*, more being required in winter and in a cold climate than in summer or in hot climates; (3) *exercise*, those persons whose occupations demand more muscular exercise need more food to supply the waste; (4) *temperament*, persons of active temperament needing more than those of a sluggish temperament; (5) *habits*, much depends on what persons accustom themselves to; (6) *mental condition*, under a depressed state of mind the degestive organs do not work so well and a less amount of food should be taken.

47. *What are necessary conditions for good digestion?*

Pure air for the lungs, and the **skin kept clean** are necessary to have pure blood, and without pure blood there can be no good digestion. A daily attention to the evacuation of the alimentary canal is also necessary to pure blood, as the waste matter in the intestines if not evacuated will be absorbed and taken into the blood, where it becomes an irritant poison.

48. *What are the organs of the Circulatory System?*

The **circulatory** system embraces the *heart*, the *arteries*, the *veins*, and the *capillaries*.

49. *Describe the heart.*

The **heart** is the engine which propels the blood. It is a hollow, pear-shaped muscle, about the size of the fist. It hangs, point downward, just to the left of the center of the chest. It is enclosed in a loose sac of serous membrane, called the *pericardium*. This secretes a lubricating fluid, and is smooth as satin.

50. *Of what do the movements of the heart consist?*

Of an alternate **contraction** and **expansion**. The former is called a *sys'-to-le* and the latter the *di-as'-to-le*. During the diastole the blood flows into the heart, to be expelled by the systole. The alternation of these movements constitutes the beating of the heart which we hear so distinctly between the fifth and sixth ribs.

51. *What are the chambers of the heart?*

The heart is divided into four chambers. In an adult, each holds about a wine-glassful. The upper ones are called **auricles,** the lower ones are termed **ventricles.** The auricle and ventricle on each side communicate with each other, but the right and left valves of the heart are entirely distinct, and perform different offices. The left side propels the red blood, and the right the dark.

52. *What is the function of the auricles and the ventricles, respectively?*

The **auricles** are merely reservoirs to receive the blood—the left auricle, as it filters in bright and pure from the lungs; the right, as it returns dark and foul from the tour of the body—and to furnish it to the ventricles as they need. On the other hand, the **ventricles** force the blood—the left, to all parts of the body; the right, to the lungs—and are, therefore, made very strong. As the left ventricle drives the blood so much further than the right, **it is** correspondingly thicker and stronger.

53. *Name and describe the valves of the heart.*

At the opening into the right ventricle is a valve consisting of three folds or flaps of membrane, whence it is called the **tricuspid** valve, and in the left ventricle, one containing two flaps, and named the **bicuspid** valve.

These flaps are strengthened like sails by slender cords, which prevent their being pressed back through the opening.

54. *What are semi-lunar valves?*

In the passage out from the ventricles are valves, called from their peculiar half-moon shape *semi-lunar* valves. Each consists of three little pocket-shaped folds of membrane, with their openings in the direction which the blood is to take. When it sets back, they fill, and swelling out, close the passage.

55. *Describe the arteries.*

The **arteries** are the tube-like canals which convey the blood from the heart to nourish the system. They carry only the red blood. They are composed of an elastic tissue, which yields at every throb of the heart, and then slowly contracting again, keeps up the motion of the blood until the next systole.

The elasticity of the arteries acts like the air-chamber of a fire engine, which converts the intermittent jerks of the brakes, or pump, into the steady stream of the hose nozzle. The arteries communicate with one another by branches or by meshes of loops, so that if the blood be blocked in one, it can pass round through another and so get by the obstacle.

56. *Trace the course of the Arterial System.*

The **Arterial System** starts from the left ventricle by a single trunk—the *aorta*—which, after giving off branches to the head, sweeps back of the chest with a bold curve—the *arch of the aorta*— and thence runs downward, dividing and subdividing, like a tree, into numberless branches, which, at last, penetrate every nook and corner of the body.

The arteries are generally located as far as possible beneath the surface, out of harm's way, and hence are found closely hugging the bones or creeping through safe passages provided for them. They are generally nearly straight, and take the shortest routes to the parts which they are to supply with blood.

57. *What is the pulse?*

At the wrist and on the temple we can feel the **expansion** of the artery by each little wave of blood set in motion by the contraction of the heart. In health, there are about seventy-two pulsations per minute. They increase with excitement or inflammation, weaken with loss of vigor, and are modified by nearly every disease. The physician, therefore, finds the pulse a good index of the state of the system and character of the disorder.

58. *What are the veins?*

The **veins** are the channels by which the blood returns to the heart. They, therefore, carry the dark or venous blood. One set of the veins creep along under the skin, where they can be seen, as in the back of the hand; another set accompany the arteries, some of which have two or more of these satellites.

Valves similar in construction to those already described (*see Answer to Question* 54) are placed at convenient intervals, especially in the lower extremities, to guide the blood in its course, and prevent its setting backward.

59. *What are the capillaries?*

The **capillaries** form a fine net-work of tubes, connecting the ends of the arteries with the veins. They blend, however, with the extremities of these two systems, so that it is impossible to

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tell just where an artery ends and a vein begins. So closely are they placed, that we can not prick the flesh with a needle without injuring, perhaps, hundreds of them.

60. *What is the lesser circulation?*

The dark blood from the veins collects in the right auricle, and going through the tricuspid valve, empties into the right ventricle. Thence it is driven past the semi-lunar valves, through the pulmonary artery, to the lungs. After circulating through the fine capillaries of the air-cells, it is returned bright and red, through the pulmonary veins, to the left auricle.

61. *What is the greater circulation?*

From the left auricle, the blood is forced past the bicuspid valve to the left ventricle; thence it is driven through the semi-lunar valves into the great aorta, the main trunk of the arterial system. Passing through the arteries, capillaries, and veins, it returns through the *venæ cavæ*, ascending and descending, gathers again in the right auricle, and so completes the "grand round" of the body. Both of these circulations are going on constantly, as the auricles contract and the ventricles expand simultaneously, and *vice versa*.

It has been estimated that a portion of the blood will make the tour of the body in about twenty-three seconds, and that the entire mass passes through the heart in from one to two minutes.

62. *How is the heat of the body distributed?*

The **natural temperature**—about 98°—is maintained by the action of the oxygen within us. The heat thus produced is distributed by the circulation of the blood.

Thus the arteries, veins, and capillaries form a series of hot-water pipes, through which the heated liquid is forced by a pump—the heart—while the heat is kept up, not by a central furnace and boiler, but by a multitude of little fires placed here and there along its course.

63. *How is the temperature of the body regulated?*

By means of the **pores** of the skin and the **mucous membrane** in the air-passages. When the system becomes too warm, the blood-vessels on the surface expand, the blood fills them, the fluid exudes into the perspiratory glands, pours out upon the exterior, and by evaporation cools the body. When the temperature of the body is too low, the vessels contract, less blood goes to the

surface, the perspiration decreases, and the loss of heat by evaporation diminishes.

64. *What of the changes going on in the body?*

The **scales** of the epidermis are constantly falling off and being replaced by fresh cells from beneath. On the continuance of this interchange depends our health and vigor. The more rapidly this change goes on, and fresh, vigorous tissue takes the place of the old, the more elasticity and strength we possess.

There is a belief that our bodies change once in every seven years. From the very nature of the case, the rate must vary with the labor we perform, the organs most used altering oftenest. To use a homely simile, our bodies are like the Irishman's knife, which, after having had several new blades and at least one new handle, was yet the same old knife as ever.

65. *What organs are termed the "Tripod of Life"?*

Death is produced by the stoppage of the action of any one of the three organs—the heart, the lungs, or the brain. They have, therefore, been termed the " **Tripod of Life.**"

"Our brains are seventy-year clocks. The Angel of Life winds them up once for all, then closes the case, and gives the key into the hand of the Angel of the Resurrection. Tic-tac! tic-tac! go the wheels of thought; our will can not stop them, they can not stop themselves; sleep can not stop them; madness only makes them go faster; death alone can break into the case, and seizing the ever-swinging pendulum, which we call the heart, silence at last the clicking of the terrible escapement we have carried so long beneath our wrinkled forehead."—OLIVER WENDELL HOLMES.

66. *Describe the Lymphatic Vessels.*

They resemble small veins in their general structure, but carry a transparent fluid instead of blood. They are closely interlaced with the blood capillaries (*see Answer to Question 61*). Their valves are more numerous than those of the veins, and the small tubes show but little disposition to unite, often running parallel with each other, in clusters, for some distance.

67. *What is the function of the lymphatics?*

They are chiefly employed in taking up and conveying to the blood vessels the waste matter resulting from the constant wear of the tissues.

They all communicate with the venous side of the circulation, so that the blood with which the lymphatic circulation is mingled is not sent out into the general circulation till it has been purified in the lungs. In brain, tendon, cartilage, or bone the office of the lymphatics is probably performed by veins. The lacteals, in their general character and work, very much resemble lymphatics.

68. *What is lymph?*

Lymph is a thin, colorless liquid, gathered up by the lymphatics. While passing through the glands, it undergoes some process of preparation not well understood, and is then returned to the circulation.

69. *How may an animal live upon its own flesh?*

Animals which hibernate are supported during the winter by the fat which their absorbents carry into the circulation from the extra supply they have laid up during the summer. In famine or in sickness a man unconsciously consumes his own flesh.

70. *What is the structure of the skin?*

The **skin** is a tough, thin, close-fitting garment for the protection of the tender flesh. Its perfect elasticity beautifully adapts it to every motion of the body.

What we commonly call the skin is only the cuticle or covering of the cutis, or true skin. The true skin, or *dermis*, is full of nerves and blood vessels, while the cuticle, or *epidermis*, neither bleeds nor gives rise to pain, neither suffers with heat nor feels the cold.

71. *What are hair and the nails?*

They are modified forms of the cuticle, or epidermis

72. *What is the structure of the hair?*

The outside of a hair is hard and compact, and consists of a layer of colorless scales, which overlie one another like the shingles of a house; the interior is porous, and probably conveys the liquids by which it is nourished.

Each hair grows from the surface of a tiny bulb by the constant formation of new cells at the bottom. The hairs themselves are destitute of feeling. Nerves, however, are formed in the hollows in which the hair is rooted, and so one feels pain when it is pulled

73. *What is the function of the hair?*

It is a protection from heat and cold, and shields the head from blows.

74. *What is the function of the nails?*

They protect the ends of the tender finger and toe, and give us power to more firmly grasp and easily pick up any object we may

desire. They enable us to perform a hundred little, mechanical acts which else were impossible.

The nail is firmly set in a groove (matrix) in the cuticle, from which it grows at the root in length and from beneath in thickness.

75. *What is mucous membrane?*

At the edges of the openings into the body, the skin seems to stop and give place to a tissue which is redder, more sensitive, more liable to bleed, and is moistened by a fluid, or *mucous* as it is called.

Every part of the body is contained in a kind of double bag, made of the tough skin on the outside, and the tender mucous membrane on the inside.

76. *Define secretion.*

Secretion is the separation from the blood by means of glands, certain materials which are in a more or less liquid condition. In some cases glands separate a material which is a mere waste and must be thrown out of the system. This act is called **excretion.**

The terms *secretion* and *excretion* are used to denote the products separated as well as the act of separation. Some liquids, as the bile, seem to partake of the nature of both a secretion and an excretion.

77. *What are oil glands?*

They are clusters of tiny **sacs** which secrete an oil that flows along the duct to the root of the hair, and thence oozes out on the cuticle. These keep the skin soft and flexible.

78. *What are perspiratory glands?*

They are fine **tubes** about $\frac{1}{300}$ of an inch in diameter, and a quarter of an inch in length, which run through the cutis, and then coil up in little balls.

They are found in all parts of the body, and in almost incredible numbers. The mouths of these glands—"pores," as we commonly call them—may be seen with a pocket lens along the fine ridges which cover the palm of the hand.

79. *What is the consistency of perspiration?*

From the perspiratory glands there constantly passes a **vapor,** forming what we call the insensible perspiration. Exercise or heat causes it to flow more freely, when it condenses on the surface in drops. The perspiration consists of about ninety-nine parts water and one part solid matter.

80. *What are the organs of the respiratory system ?*

They are primarily the **lungs,** assisted by the *larynx, trachea, diaphragm,* and the *ribs* and *muscles* of the **thorax.**

81. *Describe the position and shape of the lungs.*

The **lungs** are two in number, one in each side of the cavity of the thorax, and separated from each other by the *mediastinum.* Each lung is of conical form, the apex extending a little above the level of the first rib and the base resting on the convex surface of the diaphragm.

The external surface is smooth, convex and corresponds in form to the interior of the cavity of the thorax. The internal surface, or that next the mediastinum, is concave.

82. *What are the respective peculiarities of the lungs ?*

The right lung is the larger ; broader on account of the heart being nearer the left side, about an inch shorter because of the diaphragm rising higher on that side to make room for the liver, and is divided by fissures into three lobes ; the left lung has only two lobes.

83. *What is the structure of the lungs ?*

The structure of the substance of the lungs is that of a light, porous, spongy, and elastic body, invested with a double covering—the *pleura*—one layer being attached to the lungs and the other to the walls of the chest. It secretes a fluid which lubricates it, so that the layers glide upon each other with perfect ease.

The lungs are lined with mucous membranes, exceedingly delicate and sensitive to the presence of anything except air.

84. *Describe the larynx.*

The **larynx** is a small muscular box, placed just behind the tongue, and at the top of the windpipe. The opening into it from the throat is called the *glottis,* and the cover, the *epiglottis.*

On each side of the *glottis* are so-called *vocal cords.* They are not really cords, but merely elastic membranes projecting from the sides of the box across the opening. Different tones of voice are produced when the cords are short, tight, and closely in contact; the lower by the opposite conditions. Loudness is regulated by the quantity of air and force of expulsion.

85. *Describe the trachea.*

The **trachea,** or windpipe, is a cylindrical tube made up of car-

tilaginous rings connected by membrane. At the lower end the trachea divides into two branches, called the right and left *bronchi.* These subdivide into the small bronchial tubes, which ramify through the lungs like the branches of a tree, the tiny twigs of which at last end in clusters of cells so small that there are 600,000,000 in all.

86. *Describe the diaphragm.*

The **diaphragm** is a strong muscle separating the chest from the abdomen, thus forming the floor of the chest. By its contraction and relaxation, assisted by the muscles of the chest and abdomen, the thoracic cavity is alternately enlarged and diminished in size.

87. *What is inspiration?*

When we draw in a full breath, we straighten the spine and throw the head and shoulders back, so as to give the greatest advantage to the muscles. At the same time the diaphragm descends and presses the walls of the abdomen outward. Thereupon, the elastic lungs expand to occupy the extra space, while the air, rushing in through the windpipe, pours along the bronchial tubes and crowds into every cell.

88. *What is expiration?*

When we expel the air from the lungs, the operation is reversed. We bend forward, draw in the walls of the abdomen, and press the diaphragm upward, while the ribs are pulled downward, thus forcing the air outward.

89. *Mention some modifications of the breath.*

Sighing, a prolonged inspiration, followed by an audible expression; **coughing,** a violent expiration in which the air is driven through the mouth; **sneezing** differs from coughing, the air being forced through the nose; **snoring,** a sleeping accompaniment, in which the air passes through both nose and mouth. **Laughing** and **crying** are very much alike, the expression of the face being necessary to distinguish between them. **Hiccough** is caused by a contraction of the diaphragm and a constriction of the glottis. **Yawning,** or **gaping,** is like sighing.

90. *What is the capacity of the lungs?*

For a man of medium height the contents of the lungs are about 330 cubic inches, or eleven pints of air.

91. *What is the action of the air in the lungs?*

In the delicate cells of the lungs the air gives up its oxygen to the blood, and receives in return carbonic acid gas and water, foul with waste matter which the blood has picked up in its circulation through the body. The blood, thus purified and laden with the inspiring oxygen, goes bounding through the system, while the air we exhale carries off the impurities.

92. *What is the evil effect of re-breathing the air?*

Our breath is air robbed of its vitality, and containing in its place a gas,—carbonic acid,—which is fatal to life, and effete matter which is disagreeable to the smell, injurious to the health, and may contain the germs of disease.

When we re-breathe air, we take back into our bodies that which has just been rejected. The muscles become inactive; the heart acts slowly; the blood stagnates; the food is undigested; the brain is clogged.

93. *Describe the nervous system.*

The **nervous system,** comprising the primary organs of sensation, is divided into the **cerebro-spinal center,** the **ganglia,** and **nerves.** It is frequently considered also as composed of two systems, the *cerebro-spinal system* and the *sympathetic* or *ganglionic system.*

94. *Of what is the cerebro-spinal center composed?*

It is composed of the **encephalon** and the **spinal cord.** The **encephalon,** or **brain,** is composed of the *cerebrum,* the *cerebellum,* the *pons varolii,* and the *medulla oblongata.*

95. *What is the weight of the brain?*

The brain occupies the entire cavity of the cranium and weighs on an average, in the adult male, 49½ oz.; in the female, 44 oz.

The brain of an idiot rarely weighs over 23 oz. Cuvier's brain weighed over 64 oz., Dr. Abercrombie's 63 oz. The human brain is relatively larger than that of any other animal, and absolutely larger than any other except that of the elephant and whale.

96. *What is the cerebrum?*

It is the largest division of the brain, resting in the anterior and middle portions of the base of the cranium. It is ovoid in form, and is divided into two lateral hemispheres, right and left.

The outer surface is thrown into folds, or *convolutions*, separated from each other by depressions called *sulci*. They are more numerous and deeper in individuals of intellectual power, and as we descend in the scale of animal life they become less complex, until the lowest orders of mammalia are reached, where they disappear entirely.

97. *What is the cerebellum?*

The cerebellum, or little brain, lies in the back and lower part of the cranium beneath the posterior part of the cerebrum. It is about one-eighth the size of the cerebrum; is oblong in form, and is divided into two hemispheres by deep notches in front and behind.

98. *What is the pons Varolii?*

The **pons Varolii**, or middle brain, lies between the hemispheres of the cerebrum, and forms a connection between the cerebrum, cerebellum, and medulla oblongata.

99. *What is the medulla oblongata?*

It is really the upper enlarged part of the spinal cord. It extends from the pons Varolii to the spinal cord, which begins at the upper part of the atlas.

100. *What is the structure or appearance of the brain?*

There are, in the cerebrum, two masses of white matter, one in each hemisphere; the white matter is surrounded by a border of gray matter. In the central part of each hemisphere of the cerebellum is a mass of white matter which sends out plates which are covered with gray matter, the whole presenting the appearance of the leaves and branches of a tree, hence called *arbor vitæ*. The pons Varolii consists of alternate layers of transverse and longitudinal white fibers intermingled with gray matter. The structure of the medulla oblongata is similar to that of the spinal cord.

101. *What is the spinal cord?*

The **spinal cord** is a long cylinder of nervous matter contained

in the spinal canal and extending from the occipital bone to the lower body of the first *lumbar vertebra*. It consists of white and gray matter like that of the brain, but differently arranged.

The white matter is on the outside, the gray in the center. It is covered with a continuation of the same membranes which invest the brain.

102. *What are the nerves?*

The nerves may be considered as extensions of the brain and spinal cord, like the branches of a tree. They are given from the **cranial** nerves of the brain, and from the **spinal** nerves of the spinal cord; there is also the **sympathetic** nerve which seems to be a kind of system itself. A **ganglion** is a small knot, or mass of nervous matter.

103. *What are the names and uses of the cranial nerves?*

The names and uses of the cranial nerves are as follows:
Olfactory, the nerve of smell.
Optic, the nerve of sight.
Motor oculi, the nerve of motion to the eye.
Trochlear, or **Pathetic,** a nerve of motion.
Trifacial, or **Trigeminus,** or nerves of common sensation in the face, eyes, nose, teeth, and jaw.
Abducens, a nerve of motion distributed to the muscle of the eye.
Portio-dura, or **Facial,** and **Portio-mollis,** or **Auditory;** nerves of the face and of the ear, respectively.
Glosso-pharyngeal, or nerve of motion and taste.
Pneumogastric, or nerve of voice, respiration, and vital organs.
Spinal accessory arises from the spinal cord, enters the skull, and is connected with the pneumogastric.
Hypoglossal, or motor nerve of the tongue.

104. *What are the spinal nerves?*

The **spinal nerves** issue from the spinal cord through apertures provided for them in the backbone. Each nerve arises by two roots; the anterior is the motory, and the posterior the sensory one.

105. *What is the sympathetic nerve?*

It consists of a series of ganglia, connected together by intervening cords, extending on each side of the vertebral column.

It is so called from the opinion entertained that through it is produced a sympathy between the affections of different organs.

106. *What is the structure of the nerves?*

The nerves are composed of bundles of fibers, which are called *funiculi,* and are inclosed in a fibrous sheath, the *perineurium;* the funiculi being separated from each other by an investing fibrous membrane, formed by reflections inward of the perineurium.

107. *What is the function of the nervous system?*

Its function is to exercise guidance and control over the other parts of the body.

108. *What is reflex action?*

A ganglion is capable of receiving an impression, and of sending back or *reflecting* it so as to excite the muscles to action. This is done without the consciousness of the mind. Thus we wink involuntarily. We start at a sudden sound. We jump back from a precipice before the mind has time to reason upon the danger.

109. *What are the uses of reflex action?*

We breathe, stand erect, walk, eat, digest, etc., without a consciousness of effort. If we were obliged to attend to every breath, every pulsation of the heart, every wink of the eye, our time would be wasted in keeping alive. An act which at first demands all our thought soon requires less, and at last becomes mechanical, that is, reflex.

110. *What are the organs of special sense?*

They are the eye, the ear, the sensitive papillæ of the skin, the tongue, and the nose.

111. *What is the form and structure of the eye?*

The eyeball is in the form of a sphere which has a segment of another sphere engrafted upon it, making its antero-posterior diameter longer than its transverse diameter, the latter being about one inch, the former a line longer.

The eyeball is composed of several coats, or tunics, which inclose certain refracting media, or humors. The first, or outer tunic, is composed of the sclerotic and cornea. The second, or

middle tunic, is composed of the choroid, iris, and ciliary pro-
cesses. The third tunic is the retina. The humors are the aqueous,
the crystalline lens and its capsule, and the vitreous.

112. *Describe the sclerotic coat.*

The **sclerotic** coat of the eye is firm and unyielding and serves
to maintain the form of the eyeball. It is of a white color and
very smooth outside except where the muscles are inserted.

113. *Describe the cornea.*

The **cornea** is the transparent part of the external tunic which
projects from the main part of the eyeball and forms about one-
sixth of the surface of the ball. It appears to fit into the sclerotic
coat as a watch crystal does in its case.

114. *Describe the choroid coat.*

The **choroid** coat is a thin, vascular, dark-colored membrane,
which lines the inside of the sclerotic coat. It is pierced behind
by the optic nerve and extends forward as far as the cornea.

115. *What are the ciliary processes?*

The **ciliary** processes are foldings of the choroid at its anterior
margin.

116. *What is the iris?*

The **iris** is a fibro-muscular curtain with a circular perforation
in its center, called the *pupil*, which is susceptible of great varia-
tion in size. The iris is of various colors in different individuals.
It is what gives color to the eye.

The muscular fibres of the iris are of two kinds, circular and radiating,
and by their alternate contractions and relaxation the pupil is diminished
and enlarged.

117. *What is the retina?*

The **retina** is really an expansion of the optic nerve. It is
composed of three layers: (1) the external or columnar, com-
posed of columnar rods, arranged perpendicular to the surface,
among which are interspersed cone-like bodies; (2) the middle or
granular layer; (3) the internal, or nervous layer.

In the center of the retina is the yellow spot, or *macula lutea*. The point

where the optic nerve enters the coats project a little beyond the surface of the retina and is destitute of nerve elements and is called the *blind spot.*

118. *What is the aqueous humor?*

The **aqueous** humor is a clear, colorless fluid contained in the space between the crystalline lens and cornea.

119. *What is the crystalline lens?*

The **crystalline** lens is a transparent body, convex on both sides but flatter on the the anterior side. It is made up of layers arranged like the coats of an onion.

120. *What is the vitreous humor?*

The **vitreous** humor is a clear, colorless fluid, albuminous, and of the consistence of thin jelly.

121. *What are the appendages of the eye?*

The eyelids, the eyebrows, the conjunctiva, and the lachrymal apparatus.

The *conjunctiva* is the mucous membrane of the eye, lining the eyelids and reflected over the front part of the eyeball.
The *lachrymal* apparatus consists of (1) the lachrymal gland, which secretes the tears and is located in the upper and outer corner of the orbit; (2) the excretory ducts which carry the tears from the gland to the surface of the eyeball; (3) the lachrymal canals which collect the tears at the inner corner of the eye and empty them into (4) the lachrymal sac, from which they are conducted into the nose through the (5) nasal duct.

122. *What, respectively, causes near-sightedness and far-sightedness?*

If the eyeball is too much rounded the rays of light are brought to a focus too soon and the person is said to be short-sighted, or near-sighted. If too much flattened the rays are not brought to a focus soon enough, and the person is far-sighted.

Near-sightedness (myopia) prevails among young persons, and far-sightedness (presbyopia) among old persons. Spectacles correct the defects by changing the focus of the rays of light.

123. *What, respectively, causes " cross-eye " and " wall-eye " ?*

The eyeball is moved by certain muscles. If those which turn the eye inward are too short, the person is " cross-eyed," or has *convergent strabismus;* if the muscles which turn the eye outward are too short he is " wall-eyed," or has *divergent strabismus.*

124. *Of what does the external ear consist?*

The **external** ear consists of: (1) a projecting portion composed of cartilage and skin called the *prima*, or *auricle;* (2) the *meatus auditorius*, or tube which leads to the middle ear.

125. *What is the tympanum, or middle ear?*

The **tympanum** is a small, irregular cavity in the petrous portion of the temporal bone, is lined with mucous membrane, communicates with the pharynx by means of the Eustachian tube, and is separated from the external ear by the *membrana tympani*, or drum of the ear.

126. *What is the labyrinth, or internal ear?*

The **labyrinth** consists of: (1) the *vestibule*, a cavity which communicates with the other parts of the internal ear and with the tympanum; (2) the *semi-circular canals*, three bony channels which communicate with the vestibule; (3) the *cochlea*, a cavity in the form of a snail shell and filled with a fluid.

127. *How do we hear?*

The waves of air strike upon the tympanum, this vibrates, and sends the motion along the chain of bones in the middle ear to the fluids of the labyrinth, where the auditory nerve receives the impression and translates it to the brain as sound.

128. *What purpose does the Eustachian tube serve?*

It serves to maintain an equilibrium of pressure between the external air and that within the tympanum, and to serve as an exit for the secretions of that cavity.

129. *What is the tongue?*

The **tongue** is the organ of *taste*. It is a muscular organ covered with a mucous membrane analagous to the skin. It contains numerous papillæ, covered with epithelium.

130. *Describe the nose.*

The **nose** is the organ of smell and is also concerned in respiration. The bridge of the nose is formed of the two nasal bones, but the larger part of the frame work is made up of cartilage.

The cartilage which separates the nostrils in front is called the *septum*.

The whole of the interior of the nasal cavities, or passages, is covered with a mucous membrane called Schneiderian membrane. The olfactory nerve ramifies in that part of the Schneiderian membrane lining the nasal passages.

131. *What is the nature of touch?*

The nerves of **touch** are spread over the whole body. It is most delicate, however, in the point of the tongue and tips of the fingers. The surface of the skin is covered with minute conical projections called *papillæ*. Each of these contains its tiny nerve-twigs, which receive the impression and transmit it to the brain, where the perception is produced.

This sense may be educated to a great degree and is more particularly acute in those who have lost their sight.

SECTION IX.

SCIENCE OF ARITHMETIC.

1. *Define quantity.*

Quantity is the amount or extent of that which may be measured; it comprehends number and magnitude.

The term *quantity* is also conventionally applied to symbols used to represent quantity.

2. *Meaning of number?*

Number is quantity conceived (thought of) as made up of parts, and answers the question, " How many ? "

Thus, a distance is a quantity; but, if we call that distance 5, we convert the notion into number by indicating that the distance under consideration is made up of parts.

3. *What is discontinuous number?*

Discontinuous number is number conceived as made up of finite parts; or it is number which passes from one state of value to another by the successive additions or subtractions of units of appreciable magnitude.

4. *What is continuous number?*

Continuous number is number which is conceived as composed of infinitesimal parts; or it is number which passes from one state of value to another by passing through all intermediate values, or states.

Number, as considered in Arithmetic, is *Discontinuous Number*. Thus 5 grows till it becomes 9, by taking on additions of units of some conceivable value. Thus time affords one. It grows by imperceptible increments (additions). These inconceivably small parts, by which time is actually made up, we call infinitesimals; and number, when conceived as made up of such infinitesimals, we call **Continuous** Number.

5. *Name the three branches of the Science of Number.*

Arithmetic, Algebra, and the **Calculus.**

6. *Define Arithmetic.*

Arithmetic is the elementary branch of the Science of Numbers.

A more complete definition of Arithmetic is: **Arithmetic** treats of *Discontinuous Number*—of its nature and properties, of the various methods of combining and resolving it, and of its application to practical affairs.

7   *What are the leading topics of Arithmetic?*

(1) **Notation,** *i. e.,* methods of representing number, as by the Arabic characters, 1, 2, 3, 4, etc., or by letters, as a, b, m, n, x, y, etc.

(2) **Properties** of Numbers, or deductions from the methods of Notation.

(3) **Reduction,** as from one scale to another, from one denomination to another, from one fractional form to another, or, in short, from any one form of expression to another equivalent form.

(4) The various methods of combining number, as by addition, multiplication, and involution.

(5) Resolving number, as by subtraction, division, and evolution.

Also all the above processes as effected by the use of any notation, and upon integral or fractional discontinuous numbers of any kind.

8. *What is a Proposition?*

A **Proposition** is a statement of something to be considered or done.

"The product of the divisor and quotient, plus the remainder, equals the dividend" is an example of Arithmetical proposition.

9. *What is a Theorem?*

A **Theorem** is a proposition which states a real or supposed fact, whose truth or falsity we are to determine by reasoning.

"If the same quantity be added to both numerator and denominator of a proper fraction, the value of the fraction will be increased," is a theorem.

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10. *What is a Demonstration?*

A **Demonstration** is the course of reasoning by means of which the truth or falsity of a theorem is made to appear.

A demonstration is often called *proof*.

11. *What is an Axiom?*

An **Axiom** is a proposition which states a principle that is so simple, elementary, and evident, as to require no proof.

Thus, "A part of a thing is less than the whole of it," is an example of an axiom.

12. *What is a Problem?*

A **Problem** is a proposition to do some specified thing, and is stated with reference to developing the method of doing it.

13. *What is a Rule?*

A **Rule** is a formal statement of the method of solving a general problem, and is designated for practical application in solving special examples of the same class.   A rule requires a demonstration.

14. *What is a Solution?*

A **Solution** is the process of performing a problem or an example.   It should usually be accompanied by a demonstration of the process.

15. *Define a System of Notation.*

A **System of Notation** is a system of symbols by means of which quantities, the relations between them, and the operations to be performed upon them, can be more concisely expressed than by the use of words.

In mathematics, as now studied, **two sets of symbols** are used to present number, quantity, viz., the *Arabic Symbols*, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, called figures, and the *Common Letters*, a, b. c, d,——x, y, z.
The Roman method, by means of the seven capital letters, I, V, X, L, C, D, M, is not now used for computing, but only for marking the number of a chapter, section, or page of a book, or for some similar purpose.

16. *What is a Unit?*

A **Unit** is one.

The character 0 is called Zero, or *Cipher*, and the other nine are called

Digits. Their respective names and significations are *one, two, three, four, five, six, seven, eight, nine.*

17. *What is a Decimal System of Notation?*

It is a system of grouping numbers into **tens**, and representing the number of groups by a digit, and the character of the group by the place of the digit.

Thus 10 units are grouped into 1 ten, 10 tens into 1 hundred, 10 hundreds into 1 thousand, etc. These groups are called **Orders**, and a group of three orders is called a **Period.**

18. *What are the primary orders and the periods?*

Units, Tens, Hundreds; the periods are named **Units, Thousands, Millions, Trillions, Quadrillions, Quintillions, Sextillions, Septillions, Octillions, Nonillions, Decillions, Undecillions, Duodecillions,** etc.

This method of making the periods consist of three figures each is peculiar to the French and Americans. The English and other European nations make six-figure periods. In pointing off for convenience of reading, these nations place the commas just as we do, but read two of the groups thus formed as a period. Thus the six-figure method of reading

7,685, 432,702, 643,752 to be read 7,685 billion, 432,702 million, 643,752; whereas we read it, 7 quadrillion, 685 trillion, 432 billion, 702 million, 643 thousand, 752.

19. *Meaning of Radix?*

The **Radix** is the number which it takes of one order to make one of the next higher; thus the radix of the common system of notation is 10.

20. *Meaning of Scale?*

The **Scale** is the law of relation between the successive orders.

The scale in *Simple* numbers has *uniform* steps, each one being 10; in *Compound* numbers the scale is usually *irregular.*

21. *Name the Laws of the Arabic System of Notation.*

They are as follows:

(1) That each digit, in itself, always represents the same number of units.

(2) That the order of these units (or of the digit) depends upon the place the digit occupies, reckoning to the left or right from units order.

(3) That the sum of the values thus represented is indicated by any succession of figures.

(4) That the 0 has no value, in itself, but is used to mark vacant orders.

In any system the number of characters needed including 0, is the same as the radix.

We can readily construct a system with any radix, as a *Binary* (radix 2), a *Ternary* (radix 3), *Quaternary* (radix 4), *Quinary* (radix 5), *Senary* (radix 6), *Septenary* (radix 7), *Octenary* (radix 8), *Nonary* (radix 9), *Undenary* (radix 11), *Duodenary* (radix 12), etc. (*See also Question* 33.)

22. *What are the primary laws of the Literal Notation?*

(1) Any letter may be used to represent any number, provided it always means the same number in the same exercise or problem.

(2) When letters representing numbers are written side by side, as in a word, their product is indicated.

(3) A number represented by Arabic characters written in connection with letters is subject to the same law as the letters; *i. e.,* it is to be taken as one of the factors making up the entire number.

Thus *a* may represent any number, and *b* any other number, and if we write them thus, *ab*, the meaning is that the number represented by *a* is multiplied by the number represented by *b*. If *a* is used for 6, and *b* for 15, *ab* is 6×15, or 90.

23. *Define a monomial, a binomial, a trinomial, a polynomial.*

An expression like 7*ax*, without any other joined with it by the signs + or —, is called a **Term,** or a **Monomial.** If there are *two* such terms joined together by either of the signs + or —, the two taken together are called a **Binomial,** as 6*bx* + 2*ay*, or 10*x* — 2*xy*. If three terms are joined in this way it is called a **Trinomial,** as 3*ay* — 2*ab* + 21*x*. Any expression consisting of more than one term is, in general, called a **Polynomial.**

24. *What is the Primary Unit of Simple Numbers?*

The **Primary Unit** of Simple Numbers is 1 of the units order; and the higher orders are tens, hundreds, thousands, ten-thousands, hundred-thousands, etc. The lower orders are tenths, hundredths, thousandths, ten-thousandths, hundred-thousandths, millionths, ten-millionths, etc.

25. *Show the use of the Decimal Point.*

When higher and lower orders of Simple Numbers are written

together, a period (.) is written at the right of units order to indicate its place. This period is called the **Decimal Point.**

HIGHER ORDERS.								LOWER ORDERS.							
Millions.	Hundred Thousands.	Ten Thousands.	Thousands.	Hundreds.	Tens.	*Prim. Units.*		Tenths.	Hundredths.	Thousandths.	Ten-Thousandths.	Hundred-Thousandths.	Millionths.	Ten-Millionths.	Hundred-Millionths.
9	4	5	6	2	3	7	.	8	1	4	5	6	8	3	7

26. *Name the Standard Units in Compound Numbers.*

(1) In Measures of Extension, the **Yard.**

(2) In Liquid Measure, the **Wine Gallon.**

(3) In Dry Measure, the **Winchester Bushel.**

(4) In Weight, the **Troy Pound.**

(5) The **Unit of Time** is the **Mean Solar Day.**

(6) In United States Money, the **Dollar.**

(7) In French Money, the **Franc.**

(8) In German Money, the **Mark.**

A *Liquid Gallon* is 231 cubic inches.
The *Winchester Bushel* is 2150.4 cubic inches, very nearly.
A *Troy Pound* is 5760 grains, a liquid gallon containing 58372.1754 grains of distilled water at its maximum density (39.83° F.) weighed in the air, the barometer being at 30 *in.*
The *Avoirdupois Pound* is 7000 grains.
The *Gold Dollar* (.9 pure gold, and .1 alloy of silver and copper) weighs 25.8 grains.

27.   *What are the units in the Metric System of weights and measures?*

The **Unit of Extension** is the **Meter** (39.37 *in.*); of **Measures of Capacity,** the **Liter** (1.0567 liquid quarts, or .908 dry quarts); and of **Weight,** the **Gram** (15.432 grains).

28. *Define Integer, Fraction, Common Fraction, Decimal, Denominator, Numerator.*

An **Integer** is an entire unit, or collection of entire units; *i. e.,* it is a *whole number* in distinction from a fraction.

A **Fraction** is a number representing one or more of the equal parts into which a unit, or some number taken as a whole, is conceived to be divided.

A **Common Fraction** is a fraction which arises from conceiving the unit, or number, divided into any number of equal parts (other than a number the same as the radix), as convenience may dictate.

A **Decimal Fraction** is a fraction in the decimal system which arises from dividing the unit by 10, and these 10ths again by 10, etc., *i. e.,* from a decimal division of the unit.

A **Denominator** of a fraction is the number which indicates into how many equal parts the unit, or number, is conceived to be divided.

The **Numerator** is the number which indicates how many of these equal parts are represented by the fraction.

29. *How read a decimal?*

Numerate the fraction; that is, begin at the decimal point and name the orders to the right, and bear in mind the name of the lowest, or right-hand order.

Read the expression just as a whole number, and then pronounce the name of the lowest or right-hand order.

30. *How write a decimal?*

Write the numerator as a whole number. Then beginning at the **right,** apply the decimal numeration, calling the right-hand figure tenths, the next at the left hundredths, etc., filling all vacant orders with 0's, till the name of the order designated by the denominator is reached; at the left of this write the decimal point.

31. *Describe the Symbols of Operation used in Arithmetic.*

The sign **+,** called *plus,* indicates addition.

The sign —, called *minus*, indicates subtraction, the number preceding it being the minuend, and the number following, the subtrahend.

The sign $\times$ indicates multiplication.

Multiplication is also indicated by the period placed in the middle of the line, thus 4·5 , and in the literal notation by writing letters in succession without any sign between them, as *abc*, which means the same as $a \times b \times c$.

The sign $\div$, or :, indicates division, the number before the sign being the dividend, and the number after the sign the divisor.

Division is also indicated by writing the dividend above the divisor with a line between them $\left(\dfrac{16}{4}, \dfrac{a}{b} \right)$, by writing the divisor on the right of the dividend with a curved line between [4)16, a)b], or by writing the divisor in a similar manner at the left.

The sign $=$, called the **Sign of Equality,** signifies that the expressions between which it is placed are equal.

The signs ( ), [ ], $\{$ $\}$, and a horizontal line over a number are **Symbols of Aggregation,** and signify that the expression enclosed is to be taken as a whole.

Thus $(3 + 6)\,(2 + 5)$ means that $3 + 6$, or 9, is to be multiplied by $2 + 5$, or 7, so that $(3 + 6)\,(2 + 5) = 63$, while $3 + 6 \times 2 + 5 = 3 + 12 + 5 = 20$. *The sign $\times$ can not extend its power, forward or backward, beyond a $+$ or $-$, without the aid of a parenthesis. To illustrate:* $2 + 3 \times 4 - 1 = 13$; $2 + 3 \times (4 - 1) = 11$ $(2 + 3) \times 4 - 1 = 19$; $(2 + 3) + (4 - 1) = 15$, $5\,(6 - 3) =$ $5 \times 3 = 15$, while $5 \times 6 - 3 = 27$. $\overline{44 - 2} \div \overline{10 - 3} = 6$, while $44 - 2 \div 10 - 3 = 41 - \frac{1}{5} = 40\frac{4}{5}$.

The colon, **:**, written between numbers, indicates the ratio of the former to the latter, which is the same thing as the former divided by the latter; thus $8 : 4$ may be read " the ratio of 8 to 4," or " 8 divided by 4," as they are equivalent expressions. The equality of two ratios is indicated by the double colon, **::**, as in proportion. This sign is exactly equivalent to $=$.

The sign $\sqrt{}$, called the **Radical Sign,** indicates the square root of the number over which it is placed, that is, one of the two equal factors.

$\sqrt[3]{}$ indicates the cube root, that is, one of the three equal factors, etc. [*There are other symbols which will be explained in due order.*]

32. *Define Reduction.*

Reduction is changing the form of an expression without altering its value.

Philosophically, to reduce an expression from one form to another is but to change the notation by means of which the number is represented.

33. *According to the laws of the Arabic notation, what does 324 in the Quinary System signify in the Decimal System?* [See also Answer to Question 21.]

The 4 represents 4 simple units, the 2 represents 2 *fives*, or 10, and the 3 represents 3 *fives* of *fives*, or 3 *twenty-fives*, i. e., 75. Hence $324_5 = 75 + 10 + 4 = 89_{10}$.

There is no established method of reading numbers written by other scales than the decimal, nor is there need of any, since such notation is merely speculation. A number represented thus, 234, in the Quinary system may be read "2 25's, 3 5's, and 4.

34. *Reduce 758_{10} to the quinary scale.*

OPERATION.

SOLUTION.—In 758 there are 151 *fives*, and 3 units over. In 151 *fives* there are 30 *fives* of *fives*, or 25's, and 1 *five* over. In 30 25's there are 6 125's and 0 25's over, and in 6 125's there is 1 625 and 1 75 over. Hence $758_{10} = 11013_5$.

$$5)758 — 3$$
$$5)151 — 1$$
$$5)30 — 0$$
$$5)6 — 1$$
$$1$$

35. *What is generalization?*

There is but a single principle running through all arithmetical reductions; viz., To pass from a higher denomination, or order, to a lower, multiply by the number which it takes of the lower to make one of the higher. To pass from a lower to a higher, divide by this number.

36. *Show in accordance with the above principle that $3458_{10} = 24002_6$.*

SOLUTION.—Since 3458 may be understood as 3458 *units*, we state the problem, "To reduce 3458 *units* to sixes, thirty-sixes, two hundred-sixteens, etc." Now as 6 units make 1 six we divide by 6; or, there will be $\frac{1}{6}$ as many sixes as units, $\frac{1}{6}$ as many 36's as 6's, etc. This is, therefore, the ordinary case of *Reduction Ascending.*

OPERATION.

$$6)3458 — 2$$
$$6)576 — 0$$
$$6)96 — 0$$
$$6)16 — 4$$
$$2$$

37. *Reduce* 24002_6 *to the decimal scale, explaining as reduction descending.*

OPERATION.

1296's	216's	36's	.	6's	Units
2	4	0		0	2

2
6
———
16   216's
6
———
96   36's
6
———
576   6's
6
———
3458   Units.

SOLUTION.—This is simply a case in *Reduction Descending.* Thus 2 1296's make 6 times as many 216's, and adding in the 4 216's, we have 16 216's, 16 216's make 6 times as many 36's, or 96 36's, etc.

38. *What is a Repetend?*

It is a decimal fraction which, after a certain order is reached, consists of a figure, or a set of figures in a given order, continually repeated. The set of figures thus repeated constitutes a *Period.* When this period commences with tenths the decimal is a *Pure Repetend;* when with any lower order, a *Mixed Repetend.*

39. *How can a common fraction always be expressed?*

As a decimal or by means of a repetend.

40. *Reduce* $.\dot{7}$ *to a common fraction.*

Observing that .111, etc., to infinity, or $.\dot{1}$, arises when we attempt to reduce $\frac{1}{9}$ to a decimal, and that .1111, etc., to infinity, or $.\dot{1}$, multiplied by 7 makes $.\dot{7}$, we find that $.\dot{7} = \frac{7}{9}$. Or, more briefly, since $.\dot{1} = \frac{1}{9}$, $.\dot{7}$ which is 7 times $.\dot{1}$ equals 7 times $\frac{1}{9}$, or $\frac{7}{9}$.

41. *What are Abstract Numbers?*

Abstract Numbers are numbers to which no other signification is attached than that of mere number, as 5, 40. 275.

42. *What are Concrete Numbers?*

Concrete Numbers are numbers applied to some objects, or to which some other significations than that of mere number is attached, as 5 *men*, $40, etc.

43. *What are the fundamental principles of the processes we call Addition?*

1. Only abstract numbers, or concrete numbers representing things of the same kind, can be added together.

2. Only like orders or denominations can be directly added together.

3. In adding related orders or denominations it is practically most convenient to add the lowest orders or denominations first; since by so doing, we are enabled to determine whether the sum of any lower order or denomination makes any integers of the higher; and, if it does, we are enabled to carry this sum forward and unite it with those higher orders as we proceed.

44. *What is a Product?*

A **Product** is a number which tells how many a certain number of times a given number makes.

45. *Define Multiplication.*

Multiplication is the process of finding the product of two numbers from a knowledge of the product of the digits, two and two or by means of the Multiplication Table.

The idea and the process of Multiplication grow immediately out of Addition; 4 times 23 means $23 + 23 + 23 + 23$; $3\frac{1}{3}$ times 76 means $76 + 76 + 76 + 25\frac{1}{3}$; and $\frac{5}{8}$ times 35 means $4\frac{3}{8} + 4\frac{3}{8} + 4\frac{3}{8} + 4\frac{3}{8} + 4\frac{3}{8}$.

46. *What is a General Problem?*

The **General Problem** in simple multiplication is, to find the product of two numbers, each represented by several digits.

47. *What are the succession of steps by which the solution of the General Problem is reached?*

1. From our knowledge of addition we ascertain what the pro-

ducts of the digits taken two and two are, *i. e.*, make the Multiplication Table.

2. Commit these products to memory, *i. e.*, learn the Multiplication Table.

3. By means of these products learn to find the product of any two numbers, each represented by several digits.

48. *What are the six Propositions of Multiplication?*

The **fundamental principles** on which the General Problem, which we call Multiplication, is based are the six following

PROPOSITIONS :

1. One number may be multiplied by another by multiplying the multiplicand by the parts of the multiplier and adding the products.

2. One number may be multiplied by another by multiplying the parts of the multiplicand by the multiplier, and adding the products.

3. One number may be multiplied by another by multiplying successively by all the factors of the multiplier; that is, by multiplying the multiplicand by one of the factors, and this product by another, and so on.

4. To multiply by 10, 100, 1000, or 1 with any number of 0's annexed, annex as many 0's to the multiplicand as there are in the multiplier; or in decimals remove the point a corresponding number of places to the right.

5. A multiplier is primarily an abstract number, and the product is of the same ORDER as the multiplier.

6. A multiplicand may be either abstract or concrete, and the product is of the same KIND as the multiplicand.

49. *Illustrate the Fifth Proposition above.*

As to the fifth Proposition, it is manifestly absurd to attempt to use a concrete number as a multiplier; thus, what could be meant by multiplying by 5 *pounds*, 4 *men*, or 7 *dollars?* A multiplier simply indicates a *number* of times which another number (abstract or concrete) is to be taken, and hence is mere number, *i. e.*, abstract.

That the product is of the same order as the multiplier becomes evident when we consider that if we multiply by units the result will be units, if by tens the result is tens, if by thirds the result is thirds, *as far* as the multiplier is concerned. Thus, to multiply any number by 1 ten (10) is to make it so many tens. So to multiply 5 by 1 third is to take ⅓ of each of the 5, making 5-thirds. Then to multiply 5 by 2-thirds is to make it 2 times 5, or 10-thirds, etc. (Thirds are orders, the same as tens or tenths.)

50. *Illustrate the Sixth Proposition above.*

With reference to the sixth Proposition, it is evident that taking several times as much of a given quantity, or taking any part of it, does not change its nature; whence the product is of the same *kind* as the thing multiplied. Thus 4 times 5 *dollars* are 20 *dollars*, and ½ of 5 *dollars* is 2½ *dollars*.

51. *Multiply 578 by 694, showing the application of Propositions 1 to 4 (answer to question 48).*

SOLUTION.—By PROP. 1 we obtain 694 times 578 by adding together 4 times 578, 90 times 578, and 600 times 578. By PROP. 2 we obtain 4 times 578 by taking 4 times 8, 4 times 7 tens, and 4 times 5 hundreds, adding to the products as we go. By PROP. 3 we obtain 90 times 578 by first taking 9 times 578 and then 10 times this product, obtaining the latter by PROP. 4. In like

$$
\begin{array}{r}
578 \\
694 \\
\hline
2312 \\
5202 \\
3468 \\
\hline
401132
\end{array}
$$

manner we obtain 600 times 578. Finally, in accordance with PROP. 2, we add these partial products and have $600 + 90 + 4$, or 694 times 578.

52. *Multiply £5 7s. 8d. by 694.*

	£5	7s.	8d.
			694
4 times £5 7s. 8d...................................	21	10	8
90 times (10 times 9 times) £5 7s. 8d...........	484	10	0
600 times (100 times 6 times) £5 7s. 8d.........	3230	0	0
694, or 600 + 90 + 4 times £5 7s. 8d.............	£3736	0s.	8d.

53. *Multiply 2300 by 5000, explaining the common method of neglecting the 0's in the process and annexing them to the product of the significant figures by* PROPS. *5 and 6 (answer 48).*

Call 23 the multiplicand, the *kind* being *hundreds*. Call 5 the multiplier, the *order* being *thousands*. The product, 115, is therefore thousands of hundreds.

54. *Define Factors.*

The **factors** of a number are the numbers which multiplied together produce it.

Thus 3 and 5 are the factors of 15; 2, 5 and 7 are the factors of 70, etc.

55. *What is a Power?*

A **power** is a product arising from multiplying a number by itself.

Thus 3×3 makes 9, whence 9 is a power of 3. So 27 is a power of 3. The *degree* of the power is indicated by the number of factors taken. Thus 4, 8, 16, 32 are, respectively, the 2d, 3d, 4th, and 5th powers of 2.

56. *What is an Exponent, and what does it indicate?*

An **exponent** is a number written a little to the right and above another number, and indicates—

1st. If a **Positive Integer**, a **Power** of the number;

2d. If a **Positive Fraction**, the numerator indicates a **Power,** and the denominator a **Root** of the number;

3d. If a **Negative Integer,** or **Fraction,** it indicates the **Reciprocal** of what it would signify if positive.

57. *What are Similar terms?*

Terms which have the same letters, affected with the same exponents, are called **Similar.**

Thus, $6a^2x$ and $-5a^2x$ are similar; $6ax^2$ and $-a^2x$, or $4bx + 7b^3x$, or $x + y$, and $a + b$ are dissimilar.

58. *Define Involution.*

Involution is the process of raising numbers to required powers. The number to be involved is called the *First Power*, or *The Root.*

Involution is but a special case of multiplication, viz., that in which the factors are equal; hence its presentation here.

59. *Involve the nine digits to squares, and cubes, respectively.*

Digits,   1, 2, 3, 4,   5,   6,   7,   8,   9.
Squares, 1, 4, 9, 16, 25, 36, 49, 64, 81.
Cubes,   1, 8, 27, 64, 125, 216, 343, 512, 729.

The square of 2×5 is 2×5 multiplied by 2×5, or $2 \times 5 \times 2 \times 5$, or $2^2 \times 5^2$, or 4×25, or 100.

The square of 2×7 is 2×7 multiplied by 2×7, *i. e.*, $2 \times 7 \times 2 \times 7$, or $2 \times 2 \times 7 \times 7$, or $2^2 \times 7^2$, or 4×49, or 196.

60. *Raise 2 to the 12th power.*

The 12th power of 2 is composed of 12 factors, each 2. Now, the square of 2 has two factors, each 2, the square of the square has 4 such factors, the square of the 4th power has 8 such factors, and the 8th power multiplied by the 4th has 12. Hence, $2^2 = 4$, $4^2 = 16$ (the 4th power of 2), $16^2 = 256$ (the 8th power of 2), $256 \times 16 = 4096$ (the 8th power of $2 \times$ by the 4th power) is the 12th power of 2.

61. *State the first Proposition of Involution.*

The square of any number contains twice as many figures as the number itself, or 1 less than twice as many.

62. *Write out a demonstration of this Proposition.*

Considering the squares of any two consecutive numbers in the series 1, 10, 100, 1000, 10000, etc. (as 100 and 1000), we observe that as the square of each is 1 with double its number of 0's annexed, the square of the second contains two more figures than the square of the first. Now, as these numbers are the *least* numbers which can be represented by their respective number of figures, the square of any intermediate number (which contains the same number of figures as the less) contains as many figures as the square of the less, and one more. But the square of any one of these numbers contains 1 less than twice as many figures as the number itself.

63. *State the second Proposition of Involution.*

The cube of any number contains three times as many figures as the number itself, or 1, or 2, less.

A demonstration analogous to the preceding may be made of this proposition.

64. *State the third Proposition of Involution.*

The square of any number made up of tens and units is the square of the tens, + twice the product of the tens by the units, + the square of the units.

Dem.—Let a represent the tens and b the units; whence $a + b$ is the number. Now $(a + b)^2 = a^2 + 2ab + b^2$, which agrees with the statement.

65. *Square 79 by Proposition 3.*

The square of 7 tens is...........................   4900
Twice the product of 9 units and 7 tens is...   1260
The square of 9 units is.........................   81
        Therefore $(79)^2 = (7 \text{ tens} + 9 \text{ units})^2 = 6241$

66. *State the fourth Proposition of Involution.*

The cube of any number made up of tens and units is the cube of the tens, + 3 times the square of the tens multiplied by the units, + 3 times the tens multiplied by the square of the units, + the cube of the units.

Dem.—Let a represent the tens and b the units; whence $a + b$ is the number. Now $(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^2$, which agrees with the statement.

67. *Cube 65 by the above principle.*

$$
\begin{aligned}
a^3 &= (6 \text{ tens})^3 &&= 216000 \\
3a^2b &= 3\ (6 \text{ tens})^2 \times 5 &&= \ \ 54000 \\
3ab^2 &= 3\ (6 \text{ tens}) \ \times 5^2 &&= \ \ \ \ 4500 \\
b^3 &= 5^3 &&= \ \ \ \ \ \ 125
\end{aligned}
$$

Therefore $65^3 = (6 \text{ tens} + 5 \text{ units})^3 = \overline{274625}$

68. *State the fifth Proposition of Involution.*

If we separate the square of any number into periods by plac-ing a point over the unit's figure, and one over each alternate figure to the left, the square of the highest order in the square root of this number is the greatest square in the left-hand period thus formed.

That is. 583696 being the square of a certain number, 49 the greatest square in 58. is the square of the highest order in the root, *i. e.*, the number of which 583696 is the square.

69. *State the sixth Proposition of Involution.*

If we separate the cube of any number into periods by placing a point over the unit's figure, and one over each third figure to the left, the cube of the highest order in the cube root of this number is the greatest cube in the left-hand period thus formed.

70. *Define Subtraction.*

Subtraction is,. primarily, the process of taking one number from another by means of a knowledge of the sums of the digits taken two and two.

That the process we call substraction is based on a knowledge of the sum of the digits taken two and two, is clear, since we say, "8 from 11 leaves 3, *because* 8 and 3 makes 11."

[The Subtrahend, Minuend, and Remainder are too familiar to need de-fining here.]

71. *What is the order of development of the subject of Subtraction?*

(1) By a knowledge of the sum of the digits two and two, we learn to recognize the remainder when any digit is taken from any number not less than itself, but less than itself + 10.

(2) By means of this knowledge we learn to find the remainder when any number is taken from another.

The fundamental principles of Subtraction are similar to those of Ad-dition (Question 43), the 3d being somewhat modified.

72. *Meaning of Difference?*

The **difference** between two numbers is the number of units which lie between them.

The difference between 7 days and 10 days is the number of days between the end of a period of 7 days and the end of a period of 10 days, *i. e.*, 3 days. The difference between 25° F. and 46° F, above 0, is the number of degrees on the thermometer scale between 25° and 46° above 0, *i. e.*, 21°. The difference between 15° above 0 and 10° below is, in like manner, the number of degrees between these points, viz., 25°.

73. *How find, for example, difference in degrees between two places both east or both west from a prime meridian?*

When two numbers are reckoned in the same direction from a common zero, their difference is found by subtracting one from the other.

74. *How, when in opposite directions from a common point?*

When two numbers are reckoned in opposite directions from a common zero, their difference is found by adding the numbers.

75. *Meaning of Positive and Negative?*

Positive and **Negative** are terms primarily applied to concrete quantities which are, by the conditions of a problem, opposed in character.

A man's *property* may be called positive and his debts negative. Distance *up* may be called positive, and distance *down* negative. Time *before* a given period may be called positive, and *after* negative. Degrees *above* 0. on the thermometer scale are called positive, and *below* negative.

76. *What of the + and — signs?*

Terms having the + sign, are called **Positive,** and those having the — sign, **Negative.** If no sign is written before a term the sign + is understood.

77. *What is true in the addition of literal number?*

(1) In adding **similar** terms, if the terms are all positive, the sum is positive ; if all negative, the sum is negative ; if some are positive and some negative, the sum takes the sign of that kind (positive or negative) which is in excess.

(2) **Dissimilar** terms are not united into one by addition, but the operation of adding is expressed by writing them in succession, with the positive terms preceded by the + sign and the negative by the — sign.

78. *How subtract one literal quantity from another?**

Change the signs of each term in the subtrahend from + to —, or from — to +, or conceive them to be changed, and add the result to the minuend.

79. *Why do we change the signs of the subtrahend?*

To get a quantity which added to the minuend will destroy out of it an amount equal to the given subtrahend.

80. *Why do we add the subtrahend with its signs changed to the minuend?*

Because, as the minuend is the sum of the subtrahend and remainder, if we destroy the subtrahend from out the minuend, we have left the remainder.

81. *What is the law of the signs in multiplication?*

If the multiplier and multiplicand have **like** signs the product is + ; but if they have **unlike** signs the product is —.

82. *How is a quantity or expression in a parenthesis to be considered?*

It is to be taken together as affected by the sign before it.

When several terms are enclosed in a parenthesis, or other equivalent symbol, *preceded by a* — *sign*, if the parenthesis is dropped, the signs of all the terms within must be changed. The reason for this is that the — sign shows that the polynomial within the parenthesis is to be substracted. Hence, we are to change the signs of its terms and add the result.

83. *Define Division.†*

Division is the process of finding how many times one number is contained in another.

Division also enables us to separate a number into any number of equal parts, and find how many there are in one of these parts.

The problem of Division may be solved by Subtraction ; but the process which we call Division is not based, primarily, upon Subtraction, but upon Multiplication.

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* This may appear like *Algebra;* but the *principle* is Arithmetical as well.

† The terms Dividend, Divisor, Quotient, and Remainder are too familiar to need defining here.

84. *Divide 2176 by 68, and show the relation of the process to Multiplication and Subtraction.*

In the first place we find how many times 68 is contained in 217 (tens) by finding how many times 6 is contained in 21. To ascertain this latter fact we appeal alone to our knowledge of products, *i. e.,* to multiplication. Thus, inasmuch as we know that $3 \times 6 = 18$, and $4 \times 6 = 24$, we know that 6 is contained in 21 3 times. Hence, *it is made probable* that 68 is contained in 217 (tens) 3 (tens) times. To test this point we *multiply* 68 by 3 (tens), and find that it *is* contained 3 (tens) times. All this part of the work is seen to be based entirely upon Multiplication.

```
68)2176(32
   204
   ‾‾‾‾
   136
   136
   ‾‾‾‾
```

Again, in order to find how much of the 2176 remains undivided, we *subtract* 3 (tens) times 68 from it, finding that 68 is contained in 2176 3 (tens) times, with a remainder of 136. This part of the process is based upon the principle that *one number is contained in another as many times as it can be subtracted from it in succession.* This principle expresses the relation which Division sustains to Subtraction.

85. *Name the order of development of the subject of Division.*

(1) To observe from our knowledge of the products of the digits two and two, what the other digit is when the product and one of the digits is given, *i. e.,* to see the Division Table in the Multiplication Table.

(2) To make the first three (at least) of the principles (*next Answer*) practically familiar.

(3) To apply the knowledge gained in the two preceding steps to the solution of the **General Problem,** *i. e.,* to divide a number represented by several digits by another number represented by several.

86. *What are the principles upon which the process called Division is founded?*

(1) Whatever number of times a given divisor is contained in a given dividend, this divisor is contained in twice this dividend twice as many times ; in 3 times this dividend, 3 times as many times ; in 10 times this dividend, 10 times as many times, etc.

(2) We may find how many times a given divisor is contained in a given dividend, by finding how many times it is contained in all the parts of the dividend and adding the results together.

(3) If a given divisor is contained in any dividend a certain number of times with a certain remainder, it is contained in 2 times that dividend 2 times as many times with 2 times as great a remainder ; in 3 times that dividend 3 times as many times with 3 times as great a remainder ; in 10 times as great a dividend 10 times as many times with 10 times as great a remainder, etc.

(4) If the dividend and divisor are considered as representing numbers of any particular **kind** (as concrete numbers), they must represent numbers of the **same kind.**

(5) If the dividend is considered as representing some particular **kind,** and the divisor is abstract, the quotient is of the same kind as the dividend.

87. *Show that $\frac{3}{5}$ is contained in 1 $\frac{2}{3}$ times.*

ANALYSIS.   EXPLANATION.

$1)1 = 1$ 1 unit is contained in 1 unit 1 time; $\frac{1}{5}$ unit be-

$\frac{1}{5})1 = 5$ ing 5 times smaller than 1 unit, is contained in 1

$\frac{3}{5})1 = \frac{5}{3}$ unit 5 times; $\frac{3}{5}$ unit being 3 times larger than $\frac{1}{5}$

unit, is contained in 1 unit $\frac{1}{3}$ of 5 times $= \frac{5}{3}$ times.

[This analysis gives the reason for inverting the divisor in division of fractions.]

88. *Divide 12.5 by .5. By .05. By 5. Deduce a practical rule from this analysis.*

In order to divide 12.5 by .5, both must be reduced to the same kind. Now 12.5 is 125 *tenths*, and .5 is 5 *tenths*. Hence, our quotient is $125 \div 5 = 25$. Again, 12.5 is 1250 *hundredths*, and .05 is 5 *hundredths*. Hence, $12.5 \div .05 = 1250 \div 5 = 250$. So, also, $12.5 \div 5 = 125 \div 50 = 2.5$.

The practical rule deduced from this analysis is as follows: Make the number of decimal places equal in each, and dropping the decimal point from both (or disregarding it), divide as in whole numbers.

89. *What Propositions are direct consequences of the definition of Division?*

PROP. 1.—Dividend and divisor may both be multiplied or both be divided by the same number without affecting the quotient.

PROP. 2.—If the dividend be multiplied or divided by any number, while the divisor remains the same, the quotient is multiplied or divided by the same.

PROP. 3.—If the divisor be multiplied by any number while the dividend remains the same, the quotient is divided by that number; but if the divisor be divided, the quotient is multiplied.

PROP. 4.—The sum of the quotients of two or more quantities divided by a common divisor, is the same as the quotient of the sum of the quantities divided by the same divisor.

PROP. 5.—The difference of the quotients of two quantities divided by a common divisor, is the same as the quotient of the difference divided by the same divisor.

90. *Define Cancellation.*

Cancellation is the striking out of a factor common to both

dividend and divisor, and does not affect the quotient, as appears from PROP. 1.

In a fraction the numerator is dividend and the denominator its divisor; hence, a fraction is regarded as an unexecuted problem in division.

91. *What is the law of the signs in Division?*

It is that **like** signs in divisor and dividend give $+$ in the quotient, and **unlike** signs $-$.

This is a direct consequence of the law of signs in multiplication.

92. *Define a Root.*

A **Root** is one of the equal factors into which a number is conceived to be resolved.

The **Square Root** of a number is one of *two* equal factors into which the number is conceived to be resolved. The **Cube Root** is one of three equal factors.

93. *How is a root indicated?*

By the **Radical,** or **Root Sign,** $\sqrt{\ }$. When written thus $\sqrt{25}$, it indicates that the square root of 25 is to be taken; that is, that 25 is to be resolved into 2 equal factors, and one of them taken. To indicate the cube root, 3 is written in the sign. Thus $\sqrt[3]{125}$ means the cube root of 125. It is 5.

In like manner the 4th root is one of the 4 equal factors which compose a number, and is indicated thus $\sqrt[4]{\ }$; the 5th root thus, $\sqrt[5]{\ }$, etc.

94. *What is Evolution?*

Evolution is the process of extracting roots of numbers.

As evolution is the process of finding one of a certain number of equal factors which compose a number, it is but a process of factoring—resolving a number into equal factors.

95. *Extract the square root of 7056.*

<div align="center">SOLUTION.</div>

$$(x + y)^2 = x^2 + 2xy + y^2 =$$
$$x^2 =$$
$$2xy + y^2 = (2x + y)y. \quad \text{Now } 2x = 160)656$$
$$y = \quad 4 \; 656$$

Whence $2x \times y = $ True Divisor, $\overline{164}$

$$7056(84$$
$$64$$

EXPLANATION.—Pointing off the number 7056, we find that there will be two figures in the root, if 7056 is a perfect power;

i. e., the root will consist of a certain number of tens + a certain number of units. Let x represent the tens and y the units, whence $x + y$ will represent the **root,** and $(x + y)^2 = x^2 + 2xy + y^2$ will represent 7056. Now the square of the tens is the greatest square in the left-hand period, *i. e.*, in 70; hence the tens digit is 8, whose square is 64. This 8 being tens its square is 6400, which subtracted from 7056 leaves 656. Hence $2xy + y^2$, which equals $(2x + y)y$, represents this remainder, 656. But $2x$ is 2×80, or 160; and as $(160 + y)y = 656$, we can find y, approximately, at least, by dividing 656 by 160 as though $160y = 656$. In this way we find that it is *probably* 4. If y is 4, $2x + y = 160 + 4$, or 164, and $164y = 656$. Multiplying 164 by 4 we find the product exactly 656. Hence, 84 is the square root of 7056.

[The rule for extraction of square root is given in the more elementary course, hence it is not repeated here.]

96. *What are the points to be made in a demonstration of the rule for extracting square root?*

1. Why the pointing is thus done.
2. Why seek the highest order in the root first.
3. Why the greatest square in the left-hand period is the square of the highest order in the root.
4. Why we bring down but one period at a time.
5. Why we form the trial divisor as we do.
6. Why we add to the trial divisor the last root figure found.
7. How we proceed when the first two figures have been determined, and why this is like the preceding part of the process.

97. *Extract the cube root of 300763.*

The ultimate practical end here is to see the rule for extracting the cube root in the formula $(x + y)^3 = x^3 + 3x^2y + 3xy^2 + y^3 = x^3 + (3x^2 + 3xy + y^2)y$.

Pointing off we see that the cube of the first figure in the root is 216, and hence that 6 is this first figure. Now, letting the x in the formula represent the six tens (60), after we have taken out the x^3 (216 thousand) we have $(3x^2 + 3xy + y^2)y = 84763.$

$$300763(67$$
$$216$$
$$\begin{array}{r|l} 10800 & \overline{84763} \\ 1360 & \\ 49 & \\ \hline 12109 & 84763 \end{array}$$

For trial putting $(3x^2)y = 84763$, as $x = 6$ tens we have $3(6 \text{ tens})^2 y = 84763$, or $10800y = 84763$, approximately. Hence 10800 is the *Trial Divisor* and 7 is the probable next figure in the root. But the *True Divisor* is $3x^2 + 3xy + y^2$, or $3xy + y^2$ more than 10800. Now $3xy = 3 \times 60 \times 7$, and $y^2 = 7^2$, whence the true divisor is $10800 + 1260 + 49$, or 12109. Multiplying this by 7 we find no remainder. Hence 67 is the exact cube root of 300763.

98. *How may higher roots than the square and the cube be extracted?*

The 4th root may be extracted by taking the square root of the square root, and the 6th root by taking the cube root of the square root.

Any root may be extracted by the method suggested by the corresponding power of a binomial, in a manner altogether similar to that for extracting the cube root.

99. *What Proposition proves the fundamental operations by casting out the nines?*

The remainder arising from dividing any integral number by 9 is the same as that which arises from dividing the sum of its digits by 9.

Dem.—Let a, b, c, and d represent the digits of a number whence the number is represented by $1000a + 100b + 10c + d$. Now since 1000 is $999 + 1$; $100, 99 + 1$; and $10, 9 + 1$, we have $1000a + 100b + 10c + d = (999 + 1)a + (99 + 1)b + (9 + 1)c + d$

$$= 999a + a + 99b + d = \overline{999a + 99b + 9c} + \overline{a + b + c + d}.$$

Now the first part of the number when put in this form is evidently divisible by 9, hence whatever remainder there may be when the whole number is divided by 9 will arise from dividing the second part by 9. But the second part is the sum of the digits.

It is evident that the same argument is applicable to any number.

100. *Illustrate the above by showing that the remainder arising from dividing 5487 by 9 is the same as arises from dividing the sum of its digits by 9.*

$5487 = 1090 \times 5 + 100 + 4 + 10 \times 8 + 7 = (999 + 1)5 + (99 + 1)4 + (9 + 1)8 + 7 = 999 \times 5 + 5 + 99 \times 4 + 4 + 9$

$$\times 8 + 8 + 7 = \overline{5 \times 999 + 4 \times 99 + 8 \times 9} + \overline{5 + 4 + 8 + 7}.$$

Now 9 exactly divides the first part, hence whatever remainder there may be when the whole number is divided by 9 will arise from dividing the second part by 9. But this second part is the sum of the digits, and gives a remainder 6 when divided by 9. So also does the number 5487.

The most convenient practical method of procedure is to add the digits in succession, dropping 9 as often as the sum amounts to this number. Thus, to reject the 9's from 785402356, we say . "11; *2, 5, 7, 11; 2, 7, 15; 6, 13, 4." This shows that the sum of the digits makes four 9's and 4 remainder. But as the remainder is all that we desire the number of 9's need not be attended to. A little practice enables us to see at a glance the excess of 9's. Thus no attention need be paid to the 9's which occur in the number or to

---

* In this, 9 is dropped from the sum at each semicolon.

any pair of digits which makes 9. In the above the 6 and 3, 5 and 4, 7 and 2 could be disregarded, leaving only 8 and 5 to be added.

101. *Add 78543, 7652, 9867, 53216, 85764, and prove the work by casting out the 9's.*

<div align="center">OPERATION.</div>

$$78543 = \qquad x9\text{'s} + \quad 0 \; Rem.$$
$$7652 = \qquad y9\text{'s} + \quad 2 \; Rem.$$
$$9867 = \qquad z9\text{'s} + \quad 3 \; Rem.$$
$$53216 = \qquad v9\text{'s} + \quad 8 \; Rem.$$
$$85764 = \qquad w9\text{'s} + \quad 3 \; Rem.$$
$$\overline{235042 = (x + y + z + v + w)9\text{'s} + 16 \; Rem.}$$
$$= (x + y + z + v + w + 1)9\text{'s} + \quad 7 \; Rem.$$

EXPLANATION.—The 78543 contains, or is equal to, a certain number of 9's + 0 remainder. Now, as we do not care particularly how many 9's this is, we call it $x9$'s. Moreover, as the remainder is all we need, we find it. So 7652 is equal to $y9$'s + 2 remainder, etc. Consequently the sum of all these numbers is equal to as many 9's as there are in all the numbers + all the remainders, *i. e.*, to $(x + y + z + v + w)9$'s + 16 remainder. But 16 makes one 9 and 7 remainder. Hence we have the entire sum equal to $(x + y + z + v + w + 1)9$'s + 7 remainder.

REMARK.—*In casting out the 9's from any number when the result is exactly 9 drop it ; but when the sum becomes two digits add these digits and proceed.*

Thus, in casting the 9's out of 7643764286, we have $8 + 6 = 14$, $4 + 1 = 5, 5 + 2 + 4 = 11, 1 + 1 = 2, 2 + 6 + 7 = 15, 1 + 5 = 6$, etc., since the remainder, after 9 is rejected from 14, is the sum of its digits, etc.

102. *What Proposition proves Multiplication by casting out the 9's?*

The excess of 9's in the product of the two numbers is equal to the excess in the product of the excesses in the two factors.

DEMONSTRATION.—Any number used as a multiplicand may be considered as a certain number, say x, of 9's + a certain excess, which we will call r. Hence any multiplicand may be represented by $x9$'s + r, or $9x + r$. In like manner letting y represent the number of 9's in the multiplier and r' (read *prime*) the excess, the multiplier may be represented by $9y + r'$. Multiplying $9x + r$ by $9y + r'$ we have for the product $81xy + 9(xr' + yr) + rr'$. But the sum of the first two terms, $81xy + 9(xr' + yr)$ is evidently divisible by 9. Hence any excess of 9's which there may be in the product arises from the excess in rr', that is, from the product of the excesses in the factors.

$$9x + r$$
$$9y + r'$$
$$\overline{9xr' + rr'}$$
$$81xy +$$
$$\overline{9yr}$$
$$81xy + 9(xr' + yr) + rr'$$

103. *How prove Subtraction by casting out the 9's?*

Take the sum of the excesses in the subtrahend and remainder, and, if this equals the excess in the minuend, the work is probably correct.

104. *How prove Division by casting out the 9's?*

To prove division by casting out the 9's, to the excess of 9's in the product of the excesses in the divisor and quotient, add the excess in the remainder; and if the excess in this sum equals the excess in the dividend, the work is probably correct.

105. *What is the test of divisibility of numbers by 2?*

(1) Any number is divisible by 2, if the right-hand figure is 0, or a digit which is divisible by 2, and not otherwise.

DEMONSTRATION.—Any number may be considered to be as many 10's as are represented by the figures exclusive of the right hand one, + the right hand figure. Now the first part is divisible by 2, since 10 is so divisible. Hence, if the second part is 0, or is divisible by 2, the whole number is, but not otherwise.

106. *Define even and odd numbers, respectively.*

An **even** number is a number which is divisible by 2. An **odd** number is one which is not divisible by 2.

Any number is even which ends with an even digit or 0, and odd if it ends with an odd digit.

107. *When is a number divisible by 3?*

Any number is divisible by 3, if the sum of its digits is so divisible, and not otherwise.

DEM.—(1) There is no digit that may not be produced in the right-hand place by multiplication; thus, $3 \times 7 = 21$, $3 \times 4 = 12$, $3 \times 1 = 3$, $3 \times 8 = 24$, $3 \times 5 = 15$, $3 \times 2 = 6$, $3 \times 9 = 27$, $3 \times 6 = 18$, $3 \times 3 = 9$. (2) a, b, c, and d, being the digits of a number, we have $(3 + 7)^3a + (3 + 7)^2b + (3 + 7)c + d$, representing the number. Now, performing the operations indicated in any term, as $(3 + 7)^3a$, each term of the result contains a certain number of 3's, + some power of $7 \times$ by one of the digits. But all those terms consisting of a certain number of 3's are, of course, divisible by 3; hence we have to examine those consisting of powers of $7 \times$ by the respective digits. These are of the form $7^3a + 7^2b + 7c + d$, or $(6 + 1)^3a + (6 +)^2b + (6 + 1)c + d$. Performing the operations indicated in the latter forms, there arise terms containing 6 as a factor, and terms consisting of sin-

gle digits; the former are divisible by three; hence, if the latter (the sum of the digits) is divisible by 3, the entire number is.

108. *When is a number divisible by 4?*

Any number is divisible by 4 if the number represented by its last two digits is divisible by 4, or if the last two figures are 0's, and not otherwise.

DEMONSTRATION.—Any number is composed of as many hundreds as are represented by the figures, exclusive of the two right hand ones, + the number represented by these figures. By any number of 100's is divisible 4. Hence, if the number represented by the two right hand figures is divisible by 4, or if the last two figures are 0, the entire number is divisible by 4, and not otherwise.

109. *When is a number divisible by 5?*

Any number is divisible by 5 if the right-hand figure is 0 or 5, and not otherwise.

110. *When divisible by 6?*

Any even number the sum of whose digits is divisible by 3 is divisible by 6, and no other number is so divisible.

No odd number is divisible by 6.

111. *When divisible by 7?*

It is possible that a number ending with any figure is divisible by 7. (For method of proving this, see 107.)

112. *When divisible by 8?*

Any number is divisible by 8 if the last three figures are 0, or if the number represented by them is divisible by 8, and not otherwise. (Demonstration similar to 108.)

113. *When divisible by 9?*

Any number is divisible by 9 if the sum of its digits is so divisible, and not otherwise. (For Demonstration, see Answer to Question 99, page 198.)

114. *When divisible by 10?*

Any number is divisible by 10 when the right-hand figure is 0, and not otherwise.

115. *Define a divisor.*

A **Divisor** of a number is an integer which divides it without a remainder. A divisor of a number is therefore a factor. A divisor is also called a Measure.

116. *Define a Common Divisor, also the Greatest Common Divisor.*

A **Common Divisor** of two or more numbers is a common integral factor; that is, a whole number which exactly divides each of the numbers. The **Greatest Common Divisor** of two or more numbers is the greatest whole number which will exactly divide each of them.

117. *Define Composite and Prime Numbers, respectively.*

A **Composite Number** is a number which is composed of integral factors other than itself and unity. A **Prime Number** is a number which has no integral factor other than itself and unity. Numbers are said to be prime to each other when they have no common factor.

118. *What three Propositions relate to Common Divisors?*

(1) A number which contains a factor not in a given number will not divide that given number.

(2) A number is divisible by the product of any number of its prime factors, no factor being used more times than it occurs in the number.

(3) The Greatest Common Divisor of two or more numbers is the product of all their common prime factors.

To find the G. C. D. of 1512, 882, and 630 :—
$$1512 = 2 \times 2 \times 2 \times 3 \times 3 \times 3 \times 7.$$
$$882 = 2 \times 3 \times 3 \times 7 \times 7.$$
$$630 = 2 \times 3 \times 3 \times 5 \times 7.$$
The prime factors common to all are 2, 3, 3, 7. Hence, $2 \times 3 \times 3 \times 7 = 126$ is the G. C. D. of 1512, 882, and 630.

119. *What two Propositions relate to the Greatest Common Divisor?*

(1) A divisor of a number is a divisor of any number of times that number.

(2) A divisor of any two numbers is a divisor of their sum and also of their difference.

120. *Give a rule for a general method of finding the G. C. D.*

To find the G. C. D. of two numbers, divide the greater by the less, and this divisor by the remainder, continuing to divide the last divisor by the last remainder until there is no remainder. The last divisor is the G. C. D. sought.

DEMONSTRATION.—In order to demonstrate this rule, let us find the G. C. D. of 42 and 138. Performing the operation according to the rule, as in the margin, we are to prove that 6 is the G. C. D. of 42 and 138.

$$42)138(3$$
$$\underline{126}$$
$$12)42(3$$
$$\underline{36}$$
$$6)12(2$$
$$\underline{12}$$

As 42 is its own G. D., if it divides 138 it is the G. C. D. sought. Trying it, we find a remainder 12. Now any divisor of 42 is a divisor of 3 times 42, or 126 (PROP. 1), and any divisor of 126 and 138 is a divisor of their difference 12 (PROP. 2). Hence, the G. C. D. sought can not be greater than 12. Moreover, any number which divides 12 and 42 divides 138 which is the sum of 12 and 3 times 42 (PROPS. 1 and 2). Thus, the question is reduced to finding the G. C. D. of 12 and 42.

In like manner we can reduce it to the question of finding the G. C. D. of 6 and 12. But this is 6. Hence, 6 is the G. C. D. of 42 and 138.

121. *How find the G. C. D. of more than two numbers?*

The common method is to find the G. C. D. of the two least numbers, and then of this G. C. D. and the next larger of the number, etc.

122. *Define a Multiple, a Common Multiple, the Least Common Multiple.*

A **Multiple** of a number is a number which contains that number as a factor.

A **Common Multiple** of two or more numbers is a multiple of each of them.

The **Least Common Multiple** of two or more numbers is the least number which is a multiple of each of them.

The **Product** of two or more numbers is a *Common Multiple* of them all, since it contains each of them as a factor. A **Multiple** of a number must contain all its factors.

123. *Give a rule for finding the L. C. M. of several numbers.*

(1) Write the numbers in a horizontal line, and divide by any prime number that will divide two or more of them without a remainder, placing the quotients and numbers undivided in a line below.

(2) Divide this line as before, and thus proceed till no two numbers are divisible by any number greater than 1. The con-

tinued product of the divisors and numbers in the last line will be the L. C. M. of the numbers.

Applying this rule to the solution of a problem we have the work in the margin.

$$\begin{array}{c|cccc}
5) & 45 & 81 & 96 & 35 \\
\hline
3) & 9 & 81 & 96 & 7 \\
\hline
3) & 3 & 27 & 32 & 7 \\
\hline
 & 1 & 9 & 32 & 7
\end{array}$$

$$5 \times 3 \times 3 \times 9 \times 32 \times 7 = \text{L. C. M.}$$

124. *What are the three methods of comparing numbers?*

1st. On the basis of **Equality,** as in the Equation; 2d. By indicating the difference between them, as when we say one number is 5 greater than another; 3d. By telling, or indicating, the quotient of one number *divided* by the other.

125. *Meaning of Ratio?*

Ratio is the quotient of one number divided by another of the same kind, the former being called the **Antecedent,** and the latter the **Consequent.**

The term *Ratio* is also applied to such forms as $6 : 2$, $\frac{7}{3}$, etc., that is, to the indicated operation of division, the : being an equivalent for ÷.

126. *Meaning of Reciprocal?*

The term **Reciprocal** is applied to a ratio as to a common fraction, signifying the quotient of 1 divided by the ratio, or the ratio inverted. So also the term **Compound Ratio** has exactly the same meaning as Compound Fraction, *i. e.*, the product of the ratios.

Thus, the reciprocal of the ratio a to b is $\frac{b}{a}$, as the ratio itself called the *Direct Ratio*, is $\frac{a}{b}$. The compound ratio a to b, c to d, e to f, means simply $\frac{a}{b} \times \frac{c}{d} \times \frac{e}{f}$, or $\frac{ace}{bdf}$ just as the compound fraction $\frac{3}{4}$ of $\frac{5}{7}$ of $\frac{11}{13}$ means $\frac{3 \times 5 \times 11}{4 \times 7 \times 13}$. The ratio of 8 to 4 being 2, the reciprocal is $\frac{1}{2}$, etc.

127. *Define Proportion.*

Proportion is an equality of ratios, the terms of the ratios being expressed.

Two ratios, at least, are required for a proportion ; hence, we have two antecedents and two consequents. Of four terms which constitute a proportion, the 1st and 4th are called **Extremes,** and the 2d and 3d **Means.**

128. *How indicate the equality of two ratios?*

The equality of two ratios constituting a proportion may be indicated by the ordinary sign of equality (=), or by the double colon (::) ; but the symbol :: means exactly the same as =.

When four numbers are in proportion, as 12, 4, 48, and 16, we say " 12 is to 4 as 48 is to 16," meaning thereby that $\frac{12}{4} = \frac{48}{16}$.

129. *What is the 4th term in the proportion 2 : 8 :: 6 : what?*

PROCESS
(by Cancellation.)

Since the product of the means divided by one extreme, gives the other extreme, write 8 and 6 for a dividend and two for a divisor.

$$\frac{8 \times \overset{3}{\cancel{6}}}{\cancel{2}} = 24$$

130. *If $\frac{2}{3}$ of a farm is worth \$240, how much is $\frac{8}{9}$ of it worth?*

The ratio of the parts being the same as that of the values, we have

$$\frac{\frac{2}{3}}{\frac{8}{9}} :: \frac{240}{x}, \text{ or } \frac{2}{3} \times \frac{9}{8} = \frac{240}{x}, \text{ and } x =$$

$$\frac{\overset{4}{\cancel{3}} \times \cancel{8} \times \overset{80}{\cancel{240}}}{\cancel{2} \times \underset{\cancel{3}}{\cancel{9}}} = 320$$

In solution, it is usually best to indicate the operations first, and then cancel as much as possible.

131. *If 12 meters of cloth cost 24 francs, how many dollars will $3\frac{1}{2}$ yards cost?*

The proportion is $\dfrac{\frac{12 \times 39.37}{12}}{3 \times 3\frac{1}{2}} :: \dfrac{24 \times .193}{x}$, whence $x =$

$$\frac{3 \times 3\frac{1}{2} \times 24 \times .193}{39.37}.$$

This method compels a full understanding of the nature of the process in proportion, which the ordinary method does not.

132. *Why is the product of the means of a proportion equal to the product of the extremes?*

The 1st *mean* is the 1st *extreme divided* by the ratio, and the 2d

mean is the 2d *extreme multiplied* by the ratio.   Hence, the product of the means is $\frac{\text{1st } Extreme}{\text{Ratio}} \times$ 2d *Extreme* $\times$ *Ratio.*   In this the Ratio cancels and leaves the product of the Extremes.

133. *If a man travels 24 mi. in 2 days, by walking 4 hr. a day, at the same rate how far will he travel in 10 da., walking 8 hr. a day?*

STATEMENT.

$$\left.\begin{array}{l} \text{2 da. : 10 da.} \\ \text{4 da. : \ 8 da.} \end{array}\right\} :: \text{24 mi. : (?) mi.}$$

CANCELLATION. $\dfrac{24 \times 10 \times \overset{2}{\cancel{8}}}{\cancel{2} \times \cancel{4}} = 240$ mi.

EXPLANATION.—Since miles are required, 24 mi. = third term.
Since in 10 da. he will walk farther than in 2 da., we make 10 da. the 2d term in the first proportion.

Since in 8 hr. he will walk farther than in 4 hr., we make 8 hr. the second term in the second proportion.

Place 3d and 2d terms above the line (for a **dividend**), and the 1st terms below (for a divisor).

134. *If 180 men, in 6 da. of 10 hr. each, dig a trench 200 yd. long, 3 yd. wide, 2 yd. deep, in how many days can 100 men, working 8 hr. a da., dig a trench 180 yd. long, 4 yd. wide, and 3 yd. deep?*

STATEMENT.

$$\left.\begin{array}{l} \text{100 men : 180 men} \\ \text{\ \ 8 hr. \ : \ \ 10 hr.} \\ \text{200 yd. : 180 yd.} \\ \text{\ \ 3 yd. \ : \ \ 4 yd.} \\ \text{\ \ 2 yd. \ : \ \ 3 yd.} \end{array}\right\} :: \text{6 da. : (?) da.}$$

CANCELLATION PROCESS.

$$\dfrac{\overset{9}{\cancel{180}} \times \overset{\cancel{5}}{\cancel{10}} \times \overset{9}{\cancel{180}} \times 4 \times \overset{3}{\cancel{3}} \times \cancel{6}}{\underset{20}{\cancel{100}} \times \underset{2}{\cancel{8}} \times \underset{10}{\cancel{200}} \times \cancel{3} \times \cancel{2}} = 24.3 \text{ da.}$$

In making a statement, the *philosophical idea* is the only sure guide; hence, in stating a question in Proportion, the mind should rest on *denominations* only; but after it is stated, we should look on the terms as abstract numbers.

When a correct statement is made, there will be the same number of elements, or factors, in similar terms; as in the above statement.

135. *What is a Progression?*

A **Progression** is a series of terms which increase or decrease by a common difference, or by a common multiplier.

136. *Define Arithmetical Progression.*

An **Arithmetical** Progression is a progression in which the terms increase or decrease by a **Common Difference.**

Thus 3 ·· 7 ·· 11 ·· 15 ·· 19, etc., is an arithmetical progression with a common difference, 4.

12 - - 10 - - 8 - - 6 - - 4 - - 2 - - 0 is an arithmetical progression with a common difference, —2.

137. *What are to be considered in any progression?*

There are **Five Things** to be considered in any progression, viz., the first term, the last term, the common difference, the number of terms, and the sum of the series. Any three of these five things being given, the other two may be found.

138. *Express the two fundamental formulæ of Arithmetical Progression.*

(1) The formula for the **Last Term,** $l = a + (n-1)d$.

(2) The formula for the **Sum of the Series,** $s = \left(\dfrac{a+l}{2}\right)n$, in

which a represents the first term, l the last term, d the common difference, n the number of the terms, and s the sum of the series.

To produce the formula for the last term of the series: Since a represents the first term and d the common difference, the second term is $a + d$; the third, $a + d + d$, or $a + 2d$; the fourth, $a + 3d$; the fifth, $a + 4d$; the sixth, $a + 5d$; that is, the series is

$$a \cdot\cdot a + d \cdot\cdot a + 2d \cdot\cdot a + 3d \cdot\cdot a + 4d \cdot\cdot a + 5d, \text{ etc.}$$

From this we see that any term consists of the first term + the common difference taken as many times as there are terms — 1. Hence, for the 9th term we have $a + (n-1)d$; or, letting l stand for the nth, or last term, $l = a + (n-1)d$.

To produce the formula for the sum of the series: Since $a \cdot\cdot a + d \cdot\cdot a + 2d \cdot\cdot a + 3d \cdot\cdot a + 4d \cdot\cdot a + 5d$, etc., to l represents the series. we have $s = a + (a + d) + (a + 2d) + (a + 3d) + (a + 4d) +$ etc., to l.

Now the term before the last is evidently $l - d$; the term before this, $l - 2d$ the term before this, $l - 3d$, etc. Hence we may write,

$s = a + (a + d) + (a + 2d) + (a + 3d) +$ etc., to $(l - 3d)$ $+ (l - 2d) + (l - d) + l.$

Or, $s = l + (l - d) + (l - 2d) \times (l - 3d) +$ etc., to $(a + 3d)$ $+ (a + 2d) + (a + d) + a.$

Adding $2s = (a + l) + (a + l) + (a + l) +$ to n term, or $n (a + l)$;

Whence, dividing by 2, we have $s = \left[\dfrac{a + l}{2}\right] n.$

It is of the utmost importance, in thus seeing in a formula the process the statement of which we call a rule. [We would suggest that the student write the rule from the formula.]

139. *Given the extremes and the number of terms, to find the common difference.*

SOLUTION.—From $l = a + (n - l)d$, find the value of d. Thus, transposing $(n - 1)d = l - a$; dividing each number by $n - l$,

$$d = \frac{l - a}{n - 1}$$

[Write the rule from the formula.]

140. *Given the extremes and the common difference, to find the number of terms.*

SOLUTION.—Solving $l = a + (n - 1)d$ for n, we have $l = a + nd$ $- d$, $nd = l - a + d$, $n = \dfrac{l - a}{d} + 1.$

[Write the rule from the formula.]

141. *Given the last term, number of terms, and common difference, to find the first term.*

As before from $l = a + (n - 1)d$, we have $a = l - (n - 1)d.$

142. *Given the sum, last and first terms, to find the number of terms.*

SOLUTION.—Since $s = \left[\dfrac{a + l}{2}\right] n$, $n = \dfrac{2s}{a + l}$

143. *Given sum, last term, and number of terms, to find first term.*

SOLUTION.—Since $s = \left[\dfrac{a + l}{2}\right] n$, $2s = an + ln$, and $a = \dfrac{2s - ln}{n}$,

or $a = \dfrac{2s}{n} - l.$

144. *Given sum, first term, and number of terms, to find last term.*

Result, $l = \dfrac{2s}{n} - a.$

145. *Given first term, number of terms, and common difference, to find sum of terms.*

SOLUTION.—As neither of the fundamental formulæ $l = a + (n-1)d$, $s = \left(\dfrac{a+l}{2}\right) n$, contains all these four quantities, $a, n, d,$ and s, we must combine the two. This we can do by substituting in $s = \left(\dfrac{a+l}{2}\right) n$, in the value of l in terms of $a, n,$ and d, that is, its value in the first formula. This gives $s = \left(\dfrac{a + a + (n-1)d}{2}\right) n,$ or $s = an + \dfrac{n(n-1)d}{2}$, as the formula required.

146. *Given last term, number of terms, and common difference, to find sum.*

This is obtained from the two fundamental formulæ in the same manner as the last, and is $s = ln - \dfrac{n(n-l)d}{2}$, or directly from the preceding formula.

There are twenty such problems, but they can not all be solved by the simple equation. The student should fix the two fundamental formulæ in mind, and know how to produce and use them. It is not desirable for him to commit to memory the formulæ in these problems, nor the rules growing out of them; but he should know how to use the fundamental formulæ in the solution of examples.

147. *Define Geometrical Progression.*

A **Geometrical Progression** is a progression in which the terms increase or decrease by a constant multiplier. If the multiplier is greater than 1 the series is called an *Increasing Progression;* if less than 1, a *Decreasing Progression.* The sign **:** is used to indicate a geometrical progression.

Thus $3 : 6 : 12 : 48$, etc., is an *increasing* Geometrical Progression in which the *Rate* is 2. $243 : 81 : 27 : 9$, etc., is a *decreasing* Geometrical Progression in which the Rate is $\frac{1}{3}$.

148. *Meaning of Rate in Progression?*

The constant multiplier by which any term of a geometrical

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progression is multiplied to produce the next term is called the **Rate, or Ratio.**

149.   *What are the two fundamental formulæ of Geometrical Progression?*

(1) The formula for the last term, $l = ar^{n-1}$
(2) The formula for the sum of the series, $s = \dfrac{lr - a}{r - 1}$

To produce the formula for the last term, observe that as the second term is the first term multiplied by the rate, the third term the first multiplied by the second power of the rate, the fourth the first multiplied by the third power of the rate, so any term is the first multiplied by the rate raised to a power denoted by the number of terms less 1. Hence if n is the number of terms, we have $l = ar^{n-1}$, as the formula sought.

To produce the formula for the sum, we have
$s = a + ar + ar^2 + ar^3 + $ etc., to $ar^{n-3} + ar^{n-2} + ar^{n-1}$.
Multiplying by r,
$rs = ar + ar^2 + ar^3 + $ etc., to $ar^{n-3} + ar^{n-2} + ar^{n-1} + ar^n$.
Subtracting, $(r - 1) s = ar^n - a.$
Whence $s = \dfrac{ar^n - a}{r - 1}$, or $s = \dfrac{lr - a}{r - 1}$, since $ar^n = lr$.

[That the student may see the arithmetical process in the formula, he should write the rules deducible from them.]

150.   *What is the formula for the sum of an Infinite Decreasing Geometrical Progression?*

$$s = \frac{a}{1 - r}$$

DEMONSTRATION.—Since the terms are growing less and less, when the series is extended to infinity l becomes 0; whence the formula $s = \dfrac{a - lr}{1 - r}$ becomes $s = \dfrac{a}{1 - r}$

151.   *Define Per Cent, Rate, Base, and Amount.*

Per cent means *by the hundred.*

The character % is used as a substitute for the words *per cent.*

Rate is the number by which we multiply to obtain any required per cent of a given number.   *Rate per cent*, therefore, means rate by the hundred.

The result obtained by taking a certain per cent of a number is called the **Percentage.**

The **Base** is the number upon which the percentage is estimated. The **Amount** is the sum of the base and percentage.

152. *What are the four things considered in Percentage?*

The **Base,** the **Rate,** the **Percentage,** and the **Amount.**

The fundamental formulæ of percentage are: (1) $p = br$, and (2) $A = b + br$, or $b(1 + r)$, in which b represents the *base*, r the *rate*, p the *percentage*. and A the *amount*.

To produce $p = br$, we have but to remember the definitions of *base*, *rate*, and *percentage*. To illustrate: Take 8 % of 345. Now 8 % of anything means .08 of it; hence 8 % of 345 is 345 $\times$ .08, and the *percentage* $= 345 \times .08$.

To produce the second formulæ we have but to remember the definition of *amount*. From this, $A = b + br$, since b is the base and br the percentage, and the sum of these two is the amount.

153. *Given amount 270, and rate per cent 8, to find the percentage and the base.*

(1) **To solve by the formulæ.**—We observe that we want a formula which gives the percentage in terms of the amount and rate. Now neither (1) $p = br$, nor (2) $A = b + br$ does this. We must therefore combine them and eliminate the quantity b, which we do not want. From $p = br$, we have $b = \dfrac{p}{r}$; and substituting this in $A = b + br$, it becomes $A = \dfrac{p}{r} + p$, from which we have $p = \dfrac{Ar}{1 + r}$ as the formula needed. Hence $p = \dfrac{Ar}{1 + r} = \dfrac{270 \times .08}{1.08} = 20.$

(2) **To analyze elementarily.**—Every 1 of base is 1.08 of amount. Hence amount 270 corresponds to $\dfrac{270}{1.08}$ of base, and as the percentage is .08 of the base, we have the percentage $\dfrac{270}{1.08} \times .08 = 20.$ In this analysis we have found the base $\dfrac{270}{1.08}$ which is 250.

154. *What business calculations based on percentage do not involve the element of Time?*

Problems of **Profit and Loss, Commission, Brokerage, Stocks, Insurance, Taxes,** and **Duties.**

155. *What calculations based on percentage involve the element of Time?*

Interest, Discount, Annuities, including many problems in **Insurance, Exchange,** and **Equations of Payments and Accounts.**

156. *Define Profit and Loss.*

Profit, or **Gain,** is the excess of what is received for an article over its total cost. **Loss** is the excess of the total cost of an article over what is received for it.

Bought a horse for $185 and sold it for $222. What per cent did I make on the investment?

In this example $222 is the amount, and $185 is the base; hence, $A = b + br$ becomes $r = \dfrac{A - b}{b} = \dfrac{222 - 185}{185} = .20$. Hence, the gain was 20 %.

[One or the other of the formulæ ($p = br$, or $A = b + br$), or both combined, will solve all questions in simple percentage.]

A man sold a house at a profit of 33⅓ %, and thereby gained $7500; required, the cost and the selling price.

Here we have $p = \$7500$, and $r = 33\frac{1}{3}$, and are required to find b, the cost, and A, the selling price. $p = br$ gives the former, as $b = \dfrac{p}{r} = \dfrac{7500}{.33\frac{1}{3}} = \dfrac{7500}{\frac{1}{3}} = 3 \times 7500 = 22500$. Now $A = b + p = 22500 + 7500 = 30000$.

Sold 5000 acres of land at $3¼ per acre, and thereby gained 22 %; what was the cost?

Here $A = 5000 \times 3\frac{1}{4}$. Having given A and r, we wish to find b, hence we use $A + b + br$, or $b = \dfrac{A}{1 + r} = \dfrac{5000 \times 3\frac{1}{4}}{1.22}$

A speculator lost $1950 on a lot of flour, which was 20 % of the cost; required the cost.

Formula, $p = br$, whence $b = \dfrac{p}{r} = \dfrac{1950}{.20} = \dfrac{1950}{\frac{1}{5}} = 5 \times 1950$. Or, as $.20 = \frac{1}{5}$, $1950 is $\frac{1}{5}$ the cost.

Having lost 12 % of my property, which was $420, how much had I remaining?

The remainder was the *difference,* and what I lost was the *percentage;* hence, we have p and r given, to find difference. Neither formula has these three quantities in it. But from (1) we have $b = \dfrac{p}{r}$, and substituting in (2) we obtain

$$\text{dif.} = \frac{p(1 - r)}{r} = \frac{420(1 - .12)}{.12} = \frac{420 \times .88}{.12} = 35 \times 88.$$

157. *Define Agent, Broker, or Commission Merchant.*

He is a person who does business for another.

Commission or **Brokerage** is the percentage paid an agent, broker, or commission merchant, and is estimated at a certain rate per cent on the amount of business done.

The **Amount** of money *received* or *expended* in behalf of another is usually the *base* on which commission is reckoned; except in case of dealings in stocks and exchange, in which cases it is customary to estimate brokerage on the *par value* of the paper.

158. *Define Tax.*

A **Tax** is money required by the government to be paid by the people of the country for the support of government, or for public enterprises.

159. *Define Real and Personal Property.*

Real Property, or **Real Estate,** is land and houses. **Personal Property** is such as furniture, goods, vessels, notes, mortgages, stocks, etc.

An **Assessor** is an officer whose duty it is to ascertain and make out a list of the taxable property in a given district. This list is called an **Assessment Roll.** A **Collector** is an officer who collects the taxes.

160. *What are Duties or Customs?*

Duties or **Customs** are taxes levied on imported articles, and are either **Specific** or **Ad Valorem.**

Specific Duties are duties levied on particular articles irrespective of their value. *Ad Valorem Duties* are duties levied on articles bought in foreign markets, and are estimated at a certain *per cent* on the net cost.

In order to collect *Duties* or *Customs* Congress determines on what articles, and what rates, and the schedule embracing these facts is called a **Tariff,**— from Tarifa, a fortress established by the Moors at the Straits of Gibraltar, where they exacted duties from all vessels entering or leaving the Mediterranean sea.

161. *Define Interest, Principal.*

Interest is money paid for the use of money. **Principal** is the sum for the use of which interest is paid.

Principal corresponds to *base*, Interest to *percentage*, and Amount to sum of principal and interest.

162. *What are the fundamental formulæ in simple interest?*

(1) $i = Prt$, and (2) $A = P + i = P + Prt = P(1 + rt)$, in which is the *Principal*, or base; r, the *Rate;* t the *Time* in years; i the *Interest*, or percentage; and A the *Amount*.

163. *What is the interest on $345 for 3½ years at 8 %?   What is the amount?   Find the amount directly from the things given.*

SOLUTION.—**By the Formulæ.—**

$$\text{(1)}\quad i = Prt = 345 \times \frac{8}{100} \times 3\tfrac{1}{2} = \frac{\overset{69}{\cancel{345}} \times \overset{4}{\cancel{8}} \times 7}{\underset{\underset{5}{\cancel{25}}}{\cancel{100}} \times \cancel{2}} = 96.60$$

$$\text{(2)}\quad A = P(1+rt) = 345(1 + \tfrac{8}{100} \times 3\tfrac{1}{2}) = 345\left[1 + \frac{8 \times 7}{100 \times 2}\right] =$$

$$345(1 + \tfrac{7}{25}) = 345 \times \tfrac{32}{25} = \frac{69 \times 32}{5} + 441.60.$$

By Elementary Analysis.—Since 8 per cent means .08 of the principal, we have $345 \times .08 = 27.60$, as the interest for 1 yr. Again, as the understanding in simple interest is that the interest is in the direct ratio of the time, if the interest for 1 yr. is $27.60, the interest for 3½ yr. is 3½ times $27.60, or $96.60.

For practical purposes the amount is found by adding the interest to the principal.

To find the amount directly from the data (things given), we consider that $1 yields $.08 in 1 year, in 3½ years it yields $.28; whence the *amount* of $1 for 3½ yr. at 8 per cent is $1.28. Hence, the amount of $345 is 345 times $1.28. $345 \times 1.28 = 441.60$.

```
        $345
         .08
        27.60
         3½
        1380
        8280
       $96.60
```

164. *At what rate per cent does $50 principal yield $5.25 in 1 year 9 months?*

BY THE FORMULÆ.—We here have P, i, and p, to find r. Hence, using $i = Prt$, we have $r = \dfrac{i}{Pt} = \dfrac{5\tfrac{1}{4}}{50 \times 1\tfrac{3}{4}} = \dfrac{21}{50 \times 7} = \dfrac{3}{50} = .06$. Therefore the rate per cent is 6.

BY ELEMENTARY ANALYSIS.—$50 in 1 yr. 9 mo. at 1%, yields $.875 interest. Hence to yield $5.25, will require a rate as many times 1 % as $.875 is contained times in $5.25, or $5.25 \div .875$, which is 6.

165. *In what time will $1260 at 8 %, amount to $1617?*

The quantities under consideration are P, r, A, and t; of which P, r, and A are given, to find t. Hence taking $A = P + Prt$, and solving for t, we have

$$t = \frac{A-P}{Pr} = \frac{1617-1260}{1260 \times .08} = \frac{357}{100.8} = 3.541\tfrac{2}{3}$$

Now 3.541⅔ yr. = 3 yr. 6 mo. 15 da.

Elementary Analysis.—The thing inquired about is *Time*, the given effect of interest.   Hence find the interest of $1260 at 8 %

for 1 yr., and divide the given interest by it. Thus $1260 at 8 % gives $100.80 in 1 yr. Hence to yield $357 will require as many times 1 yr. as $100.80 is contained times in $357, etc.

166. *What principal amounts to $232.50, in 2 yr. 11 mo., at 10 %?*

We have under consideration P, A, t, and r. As P is the thing sought, we solve $A = P(1 + rt)$ for P and have

$$P = \frac{A}{1 + rt} = \frac{232.50}{1 + \frac{1}{10} \times 2\frac{11}{12}} = \frac{232.50}{1 + \frac{7}{24}} = \frac{232.5 \times 24}{31} = 180.$$

Elementary Analysis.—The given effect is *amount*, and the thing inquired about is *principal*. Hence, as $1 principal amounts to 1.29\frac{1}{6}$ in 2 yr. 11 mo., at 10 %, it will require as many times 1 dollar principal to amount to $232.50, as 1.29\frac{1}{6}$ is contained times in $232.50, or $180.

167. *In what time will $419.84 yield $41.28 interest, at 5 %?*

$i = Prt$, contains the things under consideration, of which t is the thing sought—the unknown quantity; hence

$$t = \frac{i}{Pr} = \frac{41.28}{419.84 \times .05} = \frac{8256}{4198.4} = 1.96646 + \text{yr.} = 1$$

yr. 11 mo. 18 da.

168. *What is the rate per cent if $450 amounts to $687 in 6 yr. 7 mo.?*

$$r = \frac{A - P}{Pt} = \frac{687 - 450}{450 \times 6\frac{7}{12}} = \frac{237}{2962.5} = .08.$$

169. *Give a good method of computing interest.*

The best practical method of computing interest is to multiply the principal by the rate, and this product by the time expressed in years.

What is the interest on $750 for 3 yr. 8 mo. 26 da., at 8 %?

OPERATION.

The form of operation in the margin will be found the most expedient for common use. Interest for 1 year, $60. Hence, for 3.73$\frac{8}{9}$ yr. it is 3.73$\frac{8}{9}$ × 60.

$$\begin{array}{r|l} 30 & 26 \\ \hline 12 & 8.86 + \\ \hline & 3.73\frac{8}{9} \\ & 60 \\ \hline \end{array}$$

224.33\frac{1}{3}$ Interest.

170. *How find exact interest.*

The method of reckoning time by subtracting the dates and calling 30 days a month and 12 months a year, of course does not get the exact time. The exact time is found by reckoning the

entire years, and the exact number of days in any fraction of a year which may be involved, and calling 1 day $\frac{1}{365}$ of a year.

171. *What are Days of Grace?*

In practical affairs interest should usually be computed for 3 days more than the nominal time. These 3 days are called **Days of Grace,** and it is optional with the creditor whether he pays his note on the day on which it nominally falls due, or any time within the 3 succeeding days. An action at law can not be brought against him till the expiration of the 3 days.

What is the exact interest on a note of $345, dated June 12, 1874, payable November 16, 1876, at 10 %?

There are 2 entire years, and $18 + 31 + 31 + 30 + 31 + 16 + 3 = 160$ da. Hence the time is $2\frac{160}{365}$ yr., or $\frac{178}{73}$. Hence we have $34.5 \times \frac{178}{73} = \$84.123+$.

172. *Give a method of finding interest by cancellation.*

Problem : Find the interest of $320 for 21 da. at 5 %.

$$\frac{\overset{40}{\cancel{8\cancel{0}}} \quad 7 \quad .01}{\underset{\underset{\underset{2}{6}}{3}}{\cancel{12} \times \cancel{30}}} = \frac{2.8}{3} = \$.93\tfrac{1}{3}$$

Explanation : Place Prin., Rate, and Time above the line (for a dividend); if for years and months, reduce to months, and place only 12 below the line (for a divisor) ; if for years, months and days, or for months and days, reduce to days, and place 12 and 30 below the line (for a divisor).

173. *What is Compound Interest?*

Compound Interest (interest on interest) is interest considered as falling due at regular intervals of time, and to be reckoned as increasing the interest bearing debt from such time.

174. *Give the fundamental formula for Compound Interest.*

It is $A = P(1 + r)^n$, in which P represents the principal, r the rate, n the number of equal intervals of time at the end of which the interest is compounded, and A the amount.

To find the amount for one year, we simply multiply the principal for that year by $1 + r$, hence at the end of the 2d year the amount is $P(1 + r) \times (1 + r)$, or $P(1 + r)^2$. This being the principal for the 3d year, the amount at the end of the year is $P(1 + r)^2 \times (1 + r)$, or $P(1 + r)^3$. Hence for n years the amount is $A = P(1 + r)^n$.

175. *What is the compound interest on $240 for 5 yr., at 10 %?*

First find the amount, $A = 240(1 + .10)^5 = 240(1.1)^5 = 240 \times 1.61051 = 386.5224$. Hence, as the interest is the amount minus the principal, we have $i = \$386.5224 - 240 = \$146.5224$.

176. *Find the compound interest on $450 at 7 % for $3\frac{3}{4}$ years.*

Find amount of $1 for the whole years, and add to it the required fractional part of the interest for the next year, as found by taking the difference between the amount for the entire years and the next amount. Thus:

Amount of $1 at 7 % for 3 yr.	$1.225043
Amount for 3 yr. $1.225043	
Amount for 4 yr. 1.310796	
Interest for 4th yr. .085753. $\frac{3}{4}$ of .085753 =	.064315
Amount of $1 for $3\frac{3}{4}$ yr. at 7 % =	$1.289358

Find a principal that yields, as amount, at compound interest at 5 % $601.965, in 3 yr.

Formula $A = P(1 + r)^n$. becomes $601.965 = P(1.05)^3$, whence $P = \dfrac{601.965}{(1.05)^3}$. The value of $(1.05)^3$ can be found by actual involution.

Find a principal which at compound interest for 2 yr. at 6 % per annum, compounded semi-annually, will yield $42.67 interest.

Since $i = A - P$, we have $i = P(1 + r)^n - P = P[(1 + r)^n - 1]$, whence $P = \dfrac{i}{(1 + r)^n - 1} = \dfrac{42.67}{(1.03)^4 - 1}$

177. *What are partial payments?*

It frequently happens that a debtor does not pay his note all at one time. In such a case, whatever is paid at any time is endorsed (credited) on the back of the note, and is called a **Partial Payment.**

178. *What is the United States Court Rule for computing interest on such notes?*

(1) Compute the interest on the principal from the date of the note to the time of the first payment. If this payment equals or exceeds this interest, find the amount and subtract the payment. Treat this remainder as a new principal, and proceed to the next payment. Continue the process till the time of settlement is reached.

(2) If any payment is less than the accrued interest, add such payment to the next, and treat the sum as one payment made at the latter date.

This rule is based upon these two principles:
(1) The principal can not be diminished until the accrued interest is paid.
(2) Interest shall not draw interest.

179. *What is the "Merchant's Rule" in Partial Payments?*

Find the amount of the principal from the date of the note to the time of settlement; find the amount of each payment from the time it was made to the time of settlement, and subtract their sum from the first result.

180. *What is the Connecticut Rule in Partial Payments?*

(1) When more than a year's unpaid interest has accrued at the time when any payment is made, the case is treated by the U. S. Court Rule.

(2) But when one or more payments are made BEFORE a year's unpaid interest has accrued, the sum of the amounts of these payments at the end of the year is subtracted from the amount due on the note at that time, provided the payments are sufficient to liquidate the interest accrued at the time they were made. If any payment does not liquidate the interest accrued at the time it is made, it is simply carried forward without interest and added to the next payment, as in the U. S. Court rule.

(3) When the final settlement is made before a year's unpaid interest has accrued, the several amounts are reckoned to the time of settlement.

181. *Define Legal Interest and Usury.*

Legal Interest is the rate per cent established by law as that

which is to be implied in an interest-bearing obligation, in which the rate is not specified.

Usury is unlawful interest. Interest greater than the legal rate, if agreed upon between the parties and specified in the contract, is not Usury.

182. *What is the method for Partial Payments on Notes "with Annual Interest"?*

Find the interest on the note for 1 year; and find also the amount of the payments made during the year, from the times they were severally made to the end of the year.

. If the payments amount to more than the interest due, take their amount from the amount of the note, and make the remainder a new principal.

But if the amount of the payments does not equal the interest due, the principal remains unchanged, and the amount of the payments is taken from the interest, the remainder being treated as deferred interest.

Proceed in this manner with each year till the time of settlement, the last period being that from the time the last annual interest fell due to the time of settlement.

183. *What is the method in Partial Payments on Notes bearing Compound Interest?*

When partial payments are made on notes bearing compound interest, compute the interest on the several payments from the time they were made to the close of the respective years in which they were made, and deduct the amount in each case from the amount of the note at the close of that year.

184. *Define Discount, Commercial Discount, Bank Discount.*

Discount is a general term used by business men to signify any deduction made from a *nominal* price, or value.

Commercial Discount is a deduction from the *nominal* price, or value, of an article.

Bank Discount is interest paid in advance, and for 3 days more than the nominal time. These 3 days are called **Days of Grace.**

185. *Define Proceeds, True Discount, Present Worth.*

The **Proceeds** or **Avails** of a note given at bank is the amount which the bank pays for the note.

True Discount is a deduction made for the present payment of a sum of money due at some future time.

The **Present Worth** of a sum of money due at some time, is a sum which, put at interest at a rate agreed upon, will in the given time amount to the sum due.

When the *Present Worth* of a note exceeds the Face of the note, this excess is called Premium.

The difference between the nominal present value (as the *face* of a note) and the *Present Worth*, is the **True Discount,** or **Premium,** as the case may be.

186. *What is the principle on which paper is discounted at bank?*

Find what the obligation will yield at maturity, compute the interest on this amount from the time the paper is discounted to its maturity, and deduct this from the amount which the note will yield at maturity.

This difference is the **Proceeds,** and the interest is the **Bank Discount.**

Bank Discount is always reckoned for the exact time in days, including the 3 days grace. Thus, a note dated December 4, and due in 2 mo. 15 da., matures $27 + 31 + 19 + 3 = 80$ da. after date.

187. *What is the principle on which Common Discount is computed?*

Find what the paper will yield at its maturity, and then find what sum put at interest at the rate of discount agreed upon, will yield the same amount at the time when the paper matures.

If the obligation is due at different times, the amount yielded at each of these times is treated as a separate obligation, and the sum of the present worths of all these amounts is the present worth of the entire obligation.

188. *Give a rule for discounting a sum due at a future time, allowing the purchaser deferred annual interest.*

To 1 add the product of the rate and time, and the product of the square of the rate into the sum of the numbers 1, 2, 3, 4, etc., to 1 less than the number of years, and by this entire sum divide the amount of the debt.

189. *Define a Company.*

A **Company** is an association of persons for transacting business.

Business Companies are of two general classes, *incorporated* and *unincorporated*. The former are spoken of as **Corporations**, and the latter as **Firms, Houses,** or **Partnerships.** A **Business Corporation** is an association authorized by special or general law to transact certain business, under a specified name.

A **Firm,** or **House,** is an association bound to each other by mutual articles of agreement for the transaction of certain business.

190. *What is Capital Stock, or Joint Stock?*

Capital Stock, or **Joint Stock,** is the amount of money paid, together with that subscribed but not yet paid in, for the purpose of carrying on the business of the company, or corporation.

When a company is formed for any particular purpose, as for example, to build and run a railroad, an estimate is made of the amount of money which will probably be needed to do the work and carry on the business, and this amount is divided up into what are called **Shares,** a share usually being $100. The subscription books are opened, and all who will are invited to "*take stock,*" *i. e.,* to subscribe. When one subscribes for a certain number of shares, he agrees to pay in for the uses of the company the amount for which he subscribes, or such part of it as may be needed, when called for, and he receives from the company a **Certificate of Stock,** which certifies that he owns so much stock in the company.

191. *What are Stocks?*

Stocks are the certificates of a corporation, signed by the proper officers, and showing that the holder owns so many shares in the capital stock of the company.

Any one who owns stocks is a **Stockholder** in the company.

192. *What are Directors of a Company?*

They are members elected by the stockholders for the general oversight and direction of the business, to which the President, Secretary, and other special officers give more immediate attention.

193. *What are Gross Earnings, and Net Earnings, respectively?*

The **Gross Earnings** of a company is the total amount of money, or its equivalent, received in the transaction of its business.

The **Net Earnings** of a company is the amount that is left after deducting from the gross earnings the expenses of conducting its business, losses, and accrued interest upon its bonds or other obligations.

The net earnings of a company are its profits, and are to be divided among the stockholders in proportion to the amount of stock which each one owns, unless otherwise determined by the directors. The net earnings may be devoted to extending the business, if the directors so determine. An **Assessment** is a sum required of stockholders to meet the losses, or expenses of the company.

194. *Define a Corporation Bond*

The **Bond** of a corporation is its certificate of indebtedness signed by the proper officers, and given under the corporate seal.

Such bonds are the notes of the corporation, and are secured by mortgage upon its property. These bonds, like other notes, are made payable at a certain time, and bear a specified rate of interest.

195. *What are Government Bonds?*

Government Bonds are certificates of indebtedness issued by the Government; as by the United States, or State government, by a county, city, school district, or other government corporation.

196. *What are Consols and Rentes, respectively?*

Consols are English government stocks. **Rentes** ("*rahnts*") are French government stocks.

197. *What is a Coupon?*

A **Coupon** is a certificate of interest attached to a bond which, on the payment of the interest, is cut off and delivered to the payor.

Stocks and Bonds are bought and sold in the market just as wheat or cotton, and the prices fluctuate according to prosperity of business, the plenty or scarcity of money, and many other circumstances.

198. *What is Stock-jobbing?*

Stock-jobbing is the business of buying and selling stocks and bonds, with a view to speculation.

199. *Meaning of Par Value?*

The **Par Value** of stock is the face of the certificate or bond.

Premium, Discount, and **Brokerage** are always reckoned on the Par Value.
When stocks sell for more than their par value they are said to be at a **Premium;** when for less they are at a **Discount.**
The **Market Value** of stock is the price per share at which it can be bought.

200. *Illustrate a transaction in Exchange.*

A merchant in Detroit wishes to pay a debt of $2,500 in New York. He may send the money by a friend, by mail, or by express; but the most common and most convenient way is to step into a *bank* in Detroit, and paying in his $2,500 with a small percentage for their trouble, get the Detroit bank's order on a New York bank for the $2,500. This order, called a *Draft*, the Detroit

merchant can send to his creditor in New York, who by stepping into the New York bank to which the order is addressed, will get his $2,500.

201. *What is Exchange?*

Exchange is a method of making payments in distant places by the use of *Drafts* or *Bills of Exchange*, without the direct transmission of money.

When the exchange is between places in the same country, it is called **Inland** or **Domestic Exchange,** and when between places in foreign countries it is called **Foreign Exchange.** Hence a **Draft** is a **Domestic Bill of Exchange.**

202. *What is a Draft?*

A **Draft,** or **Bill of Exchange,** is a written order for money, drawn in one place and payable in another.

203. *What is a Bank?*

A **Bank** is a company authorized by law to issue paper money, receive deposits, deal in exchange, loan money, or buy and sell coin.

Some banks make it their chief business to loan money, others to deal in exchange, others to receive deposits, while comparatively few are banks of issue, that is, issue paper currency.

204. *Give a form of draft drawn by one bank upon another.*

FIRST NATIONAL BANK OF DETROIT.

$2,500   DETROIT, MICH., July 26, 1884.

At sight, pay to the order of Newcomb, Endicott & Co., TWENTY-FIVE HUNDRED DOLLARS.   SCHUYLER GRANT, *Cashier.*

To the NINTH NATIONAL BANK, }
        New York, N. Y. }

The above is a **Sight Draft,** *i. e.,* it is to be paid as soon as presented to the bank in New York.

205. *Give a form of draft drawn by a merchant upon a bank.*

$3,500.   DETROIT, MICH., July 26, 1884.

At ten days sight, pay to the order of Sheldon & Co., THIRTY-FIVE HUNDRED DOLLARS, value received, and charge the same to the account of   E. B. SMITH & Co.

To the TWELFTH NATIONAL BANK, }
        New York. }

The above is a **Time Draft,** and is not payable till *ten* days after presentation. It should be presented as soon as received, when the cashier writes on it "accepted," giving the date of acceptance and signing his name as cashier. This makes the bank liable for it, and is an agreement to pay it after ten days. If no time is specified when a draft is to be paid, it is payable on sight. Drafts are also made payable a certain time after date.

206. *If a New York house wishes to pay a debt in a small Western place, for instance, what would be the course?*

They would send to their creditor their check (order) upon a bank in New York, or a Certificate of Deposit. This will be at par in the Western place, and perhaps a little above.

Find the cost to a New York merchant to pay a New Orleans debt of $2500, New York exchange being at $\frac{1}{10}$ % premium in New Orleans?

The New York merchant must send a draft which will amount to $2500 including the $\frac{1}{10}$ %, which the New Orleans man will receive as premium. Hence, the problem is the ordinary one in percentage, in which the amount ($2500), and the rate (.001) are given to find the base. Hence we have

$$b = \frac{A}{1+r} = \frac{\$2500}{1+.001} = \frac{\$2500}{1.001} = \$2497.50 + .$$

207. *What is a $1200 St. Louis draft at $\frac{30}{33}$ da., on New York worth, N. Y. exchange being 101, and the time discount being at 3 %?*

The nature of this transaction is that a man in St. Louis buys at a bank there a draft on N. Y. for $1200. Since N. Y. exchange is at 101, *i. e.,* at 1 % premium, if his draft were a *sight* draft it would cost him $1200 × 1.01 = $1212. But inasmuch as the bank in N. Y. will not have to pay the draft till $\frac{30}{33}$ da. after its date, they will not charge the St. Louis bank with it till they pay it. Hence, the St. Louis bank will have the use of the money $\frac{30}{33}$ da. before it will be charged to them in N. Y., *i. e.,* before they have to pay it. Therefore they allow 3 % discount on the *face of the draft* for the use of the money. 3 % of $1200 for $\frac{30}{33}$ da. is $3.25. Hence the purchaser of the draft pays $1212 — $3.25, or $1208.75, or $1208.77 including a stamp.

208. *Give an illustration of Foreign Exchange.*

James Howell, a young man from Chicago, is traveling in England, and his father, Thomas Howell, wishes to send him in London $1000. How will he effect it? and what amount in English currency will the son receive, sterling exchange being quoted at 4.89½, and gold at 114?

ANSWER.—The father may go to a Chicago bank which deals in foreign exchange, and get a *bill of exchange* on London. As gold is at 114, $1000 in currency is equivalent to $\frac{\$1000}{114} = \$877.19$ in gold. Hence, the face of the bill will be $\frac{877.19}{4.895} = 179.2 +$, or £179 4s.

Mr. Howell will receive from the bank *three* bills of exchange (orders on the London bank) of the following form:

£179 4s.   CHICAGO, ILL., March 7, 1876.

At sight of this **First** of Exchange (Second and Third of same date and tenor unpaid), pay to the order of James Howell **One Hundred and Seventy-nine Pounds and Four Shillings** sterling, value received, and charge the same to   BROWN, GALE & CO.

To SUNDERLAND & HATCH, *London.*

The other two bills will be exactly like this, except that in the second the word **Second** will be used where **First** is in this, and the parenthesis will read "First and Third of same date," etc. The third will read "**Third** of Exchange (First and Second of same date, etc.)."

The object of this arrangement is that the three bills may be sent by different mails, and thus if one is lost the remittance will not fail. Of course when one has been received and paid the others are void.

209. *What are Quotations?*

Quotations are the statements made from day to day in the *newspapers,* giving the rates at which exchange, stocks, bonds, etc., are being bought and sold in the money market. These quotations are *gold values.*

Quotations of London exchange give the value of £1 in dollars, the par value of £1 being $4.8665; when London exchange is quoted more than this it is at *premium;* when less, at *discount.*

Quotations of Paris, Antwerp, and Geneva exchange give the value of $1 in *francs.* The par value of a franc being .193, $1 = 5.18 francs +. Hence, when quotations are less than 5.18 this exchange is at a premium; when greater, at discount.

210. *Meaning of Course of Exchange?*

The price at which exchange is quoted is often called **The Course of Exchange.**

211. *What is Equation of Payments?*

Equation of Payments is the process of finding the mean or average maturity or date of several obligations.

The **Term of Credit** is the period from the date to the maturity of an obligation.

The **Equated Time** is the equitable date for the payment of several obligations maturing at different dates.

212. *State a rule which covers all cases of Equation of Payments and Averaging Accounts.*

Find the interest which would accrue on each obligation (at

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any rate per cent, when none is named), from its maturity to the most remote maturity. Then ascertain how long it would take the sum of the obligations, or the unpaid balance, to produce the sum of these interests, or the balance of interest, at the same rate per cent. Subtract this time from the date of the most remote maturity, or add it, as the case may require, and the result will give the Equated Time.

213. *Define Insurance.*

Insurance is a branch of business in which companies called *Insurance* Companies make contracts to pay specified sums of money to other parties, in the event of certain losses to which the latter may be liable, the company receiving a percentage on the sum guaranteed.

The contract is called a **Policy.** The sum which the party insured pays to the company is called the **Premium.**

214. *What are the two principal departments of the Insurance business?*

Property Insurance and Life Insurance.

The chief department of Property Insurance is **Fire Insurance,** in which the guarantee is against loss by fire. **Marine Insurance** is insurance against the contingencies of loss to vessels or property on them.

Insurance companies are of two principal kinds, **Stock** and **Mutual.** In the former the profits are shared and the losses borne by the stockholders in the ratio of their stock, after paying the expenses of the company; in the latter these are shared by the *Insured,* or *Policyholders,* who are in fact the stockholders.

Property is not usually insured for more than three-fourths its market value, and specially endangered property will not be insured at all by judicious companies.

215. *What is an Annuity?*

An Annuity is a sum of money payable annually, or at other regular intervals.

A *Certain Annuity* is one which continues for a limited time. A *Perpetual Annuity,* or a *Perpetuity,* continues forever. A *Contingent Annuity* is one whose commencement, or duration, or both, is limited, as by a person's death, or by his arrival at a certain age. An Annuity in *Reversion,* or *Deferred,* is one which begins at some future time. An Annuity in *Arrears,* or *Foreborne,* is one the payment of which has not been made when due.

The **Amount** of an annuity is the sum of all the payments, plus the interest of each payment, from the time it became due.

The **Present Worth** of an annuity is such a sum of money as will in the given time and rate per cent amount to the final value.

216. *Define a Single Life Annuity, and a Temporary Life Annuity.*

A Single Life Annuity is an annuity payable during the life

of a specified individual; it is a *contingent annuity*, dependent on the life of the individual.

A **Temporary Life Annuity** is an annuity payable for a specified number of years, provided the person named lives through that period, but which ceases at the annuant's death, if this occurs before the expiration of the time.

Of course, if it were possible to tell how long a *Life Annuant* would live, the case would be one of annuity certain. But inasmuch as this can not be, we are obliged to resort to the theory of probabilities, based upon the average duration of life, and the chances that a person at any given age will live till any other given age. Such tables are called *Mortality Tables*, Of these there are several in more or less general use, as for example, the *Northampton*, the *Carlisle*, the *Combined Experience*, and the *American Experience*.

217. *Meaning of the Mathematical Probability of an event?*

The **Mathematical Probability** of an event is the number of favorable opportunities divided by the whole number of opportunities. The **Mathematical Improbability** is the number of unfavorable opportunities divided by the whole number of opportunities.

ILLUSTRATION.—A man draws a ball from a bag containing 5 white and 2 black balls; the opportunities favorable to drawing a white ball are *five*, and the whole number of opportunities is seven; hence the mathematical probability of drawing a white ball is $\frac{5}{7}$. The mathematical probability of drawing a black ball is $\frac{2}{7}$.

218. *What is a Joint Life Annuity?*

A **Joint Life Annuity** is an annuity contingent on the survival of all of several persons.

219. *What is a Survivorship?*

A **Survivorship** is an annuity contingent upon the survival of either of two or more lives.

The **Improbability** of an event is the difference between certainty and the probability, *i. e.*, it is 1 — the probability; or it is the *unfavorable* opportunities divided by the whole number of opportunities.

220. *Define Life Insurance.*

Life Insurance is the guaranteeing of money contingently on human life.

As to the *Constitution of the Company*, Life Insurance Companies may be **proprietary, mutual, or mixed,**—*Proprietary*, when the stock is subscribed and the company constituted in the ordinary way of organizing business

organization; *Mutual*, when each person insured becomes a member of the company, and hence is both insured and insurer; *Mixed*, when both features are combined.

Policies are **Life Policies** when the amount guaranteed is due on the death of the insured; **Term Policies** when this sum is payable upon the death of the insured, provided it occurs within a specified time; **Endowment Policies** when the guanantee is payable when the insured reaches a certain age, or at his death if it occurs before he reaches that age.

221. *Define the kinds of Premiums.*

Premiums are **Single** when the insurer pays in advance the entire sum necessary to secure the payment of the special sum at death; **Limited** when the entire premium is to be paid in a specified number of payments; and **Annual** when the insurer pays a stipulated sum annually during the lifetime of the insured.

Net Premium is the premium which two considerations—probability of life and interest on premiums—would demand.

Loading is the amount added to the net premium to cover the estimated expenses of the company, and to provide for unusual mortality or other exigencies which can not be foreseen.

222. *What is Simple Partnership?*

Simple Partnership is a partnership in which the capital of each partner is employed for the same time.

223. *What is Compound Partnership?*

Compound Partnership is a partnership in which the capital of the partners is employed for different periods of time.

224. *What are the several units of measures and weights in the Metric System?*

(1) The **Unit of Length,** called the **Metre** (*mee′-ter*), from which the system derives its name. It is nearly one ten-millionth of a quadrant of the earth's circumference.

(2) The **Unit of Area,** called the **Are** (*air*), is a square whose side is 10 metres. It contains 100 square metres.

(3) The **Unit of Solidity,** called the **Stare** (*stair*), is a cube whose edge is one metre.

(4) The **Unit of Capacity,** called the **Litre** (*lee′-ter*), contains a volume equal to that of a cube whose edge is one-tenth of a metre.

(5) The **Unit of Weight,** called the **Gramme** (*gram*), is the weight of a cube of distilled water whose edge is one-hundredth of a metre.

225. *What are the multiples and sub-multiples of the Metric System?*

For multiples, Greek numerals are used :
Deka, 10; Hecto, 100; Kilo, 1000; Myria, 10,000.
For sub-multiples the Latin ordinals are used :
Deci, 10th; Centi, 100th; Milli, 1000th.

Dekametre . . . . means		10 Metres.
Dekagramme	"	10 Grammes.
Hectometre	"	100 Metres.
Kilometre.	"	1000 Litres.
Myriagramme	"	10000 Grammes.
Centigramme	"	$\frac{1}{100}$ Gramme.
Milligramme	"	$\frac{1}{1000}$ Gramme.

SECTION X.

GEOMETRY.

1. *What is Geometry?*

Geometry is the science of magnitude.

2. *Define a Solid, a Surface, a Line, a Point, a Magnitude.*

A Solid is a magnitude having length, breadth, and thickness.

A Surface is a magnitude having length and breadth, without thickness.

A Line is a magnitude having length, without breadth or thickness.

A Point has only position, without extent.

A Magnitude is that which has only extent and form.

Similar Magnitudes are those that have the same form. *Homologous* points are similarly situated points in similar magnitudes. The term *homologous* is also applied to similarly situated lines, or surfaces, of similar magnitudes. *Equivalent* Magnitudes are those that have the same extent.

3. *What is a Geometrical Figure?*

It is any line, surface, solid, or combination of these magnitudes that can be described in exact terms.

Figures are represented by diagrams, and by models. Points are represented by capital letters. Figures are usually designated by naming some of their points. Sometimes, when a figure is designated by a single letter, the small letters are used.

4 *Define a Straight line, a Curve line.*

A Straight line is one that has the same direction through its whole extent.

A Curve is a line that has a continuous change in direction.

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5. *Repeat the two axioms of straight lines.*

(1) AXIOM OF DIRECTION.—In one direction from a point there can be only one straight line.

(2) AXIOM OF DISTANCE.—The straight line is the shortest that can join two points.

6. *Name the Corollaries we have from the Axiom of Direction.*

(1) From one point to another there can be only one straight line.

(2) If two straight lines have two points common, or if they have the same direction from a common point, they must coincide; they are one line.

(3) The position of a straight line is determined by two points, or by one point and one direction.

(4) If any figure revolves about a straight line, the line itself remains fixed in position.

7. *What is a Plane? A Curved Surface?*

A Plane is a surface that never varies in direction.

A Curved Surface is one in which there is a change of direction at every point.

A *Plane Figure* is one whose points all lie in one plane.

A *Polygon* is a portion of a plane bounded by straight lines. The straight lines are the sides of the polygon. The *Perimeter* of a polygon is its boundary, or the sum of all the sides. A *Triangle* is a polygon of three sides; a *Quadrilateral* has four sides; a *Pentagon*, five; a *Hexagon*, six; an *Octagon*, eight; a *Decagon*, ten; a *Dodecagon*, twelve; and a *Pentedecagon*, fifteen.

8. *Define a Circle.*

A Circle is a portion of a plane bounded by a curve that is everywhere equally distant from a point within. The curve is the circumference, and the point is the center.

9. *What is Plane Geometry? Solid Geometry?*

Plane Geometry is that branch of the science which treats of plane figures. Geometry of Space treats of figures whose points are not all in one plane.

10. *What are the Figures of Space treated of in Elementary Geometry?*

(1) Unenclosed figures that consist of straight lines and planes;
(2) Enclosed figures that are bounded by planes, and are called

polyedrons ; and (3) Three enclosed figures bounded by curved surfaces, the cone, the cylinder, and the sphere.

11.   *What fundamental truths are the basis of the science of Geometry ?*

Two postulates and two axioms.   Every geometrical conception, however simple or complex, is composed of two kinds of elements —directions and lengths or distances.   The directions determine its form, and the distances its extent.

12.   *Define the various kinds of angles.*

A Straight angle is one whose arms have exactly opposite directions, so that they form one straight line.

Adjacent angles are two angles that have the same vertex and one common arm between them.

Vertical angles are the opposite angles formed by two intersecting lines.

A Right angle is formed when one line meets another making the adjacent angles equal.

A Perpendicular to a line is another line making a right angle with it.

An Oblique angle is one neither a right angle nor a multiple of a right angle.

An Acute angle is one that is less than a right angle.

An Obtuse angle is one that is greater than a right angle, and less than a straight angle.

Complementary angles are two whose sum is equal to a right angle.   Each is the complement of the other.

Supplementary angles are two whose sum is equal to a straight angle.   Each is the supplement of the other.

Corresponding angles are any two having their vertices at different points, both being on the same side of the secant, and on the same side of the two lines cut.

Alternate angles are any two having their vertices at different points and being on opposite sides of the secant and on opposite sides of the two lines cut.

Interior angles are those between the two lines ; the others are exterior.

13.   *Define some terms pertaining to Circumferences.*

(1) A Radius is a straight line from the center to the circumference.

(2) A Diameter is a straight line through the center with both ends in the circumference.

An Arc is a portion of a curve.

A Chord is a straight line joining the ends of an arc.

A Major Arc is one greater than a semi-circumference; a Minor Arc is one less than a semi-circumference.

14. *What are Direct and Indirect Demonstrations?*

A Direct Demonstration proceeds from established premises by a regular deduction.

An Indirect Demonstration begins with the conclusion.

It proceeds by these steps:
1st. Suppose that the conclusion to be demonstrated is not true. This supposition is called the false hypothesis.
2d. Show, by reasoning upon the false hypothesis, that it involves a contradiction, or leads to an impossible conclusion. This contradiction or impossibility is called the absurd conclusion, and, hence, this method is called *reductio ad absurdum.*
3d. Since the supposition that the conclusion is false leads to an absurd ity, the conclusion must be false.

15. *What is the Method of Exhaustions? Of Indivisibles?*

It was used by Euclid in the demonstration of a theorem that involved a ratio between magnitudes that have no common measure.

The Method of Indivisibles consists in regarding magnitudes as composed of infinitely small elements, called *Infinitesimals* or *Indivisibles.*

16. *What is a Determinate Problem? An Indeterminate Problem?*

A Determinate Problem is one that admits of a definite number of solutions; as the problem, to draw a circumference through two given points, with a given radius. A problem is Indeterminate when it admits of an indefinite number of solutions.

17. *Define the various kinds of Triangles.*

An Acute-angled triangle has all its angles acute.

A Right-angled triangle has one of the angles right.

An Obtuse-angled triangle has one of the angles obtuse.

An Equilateral triangle has three sides equal.

An Isosceles triangle has only two sides equal.

A Scalene triangle has no two sides equal.

The Hypotenuse of a right-angled triangle is the side that subtends the right angle.

The Altitude of a triangle is the perpendicular distance between one side and the vertex of the opposite angle. This side is called the *base*, and the opposite vertex is called the vertex of the triangle. A *medial* of a triangle is a line from the vertex to the midpoint of the base.

18. *When is a circle said to be circumscribed and when inscribed?*

When a circumference passes through the vertices of all the angles of a polygon, the circle is said to be *circumscribed* about the polygon, and the polygon to be *inscribed* in the circle. When every side of a polygon is tangent to a circumference, the circle is *inscribed* and the polygon *circumscribed.*

A circle that touches one of the three sides of a triangle and the other two sides produced is called an *escribed* circle.

19. *What is a Trapezoid?*

A Trapezoid is a quadrilateral that has two sides parallel. The parallel sides are called bases.

20. *What is a Parallelogram? A Rectangle?*

A Parallelogram is a quadrilateral that has its opposite sides parallel.

A Rectangle is a right-angled parallelogram.

21. *What is a Rhombus.*

A Rhombus, or Lozenge, is a parallelogram that has all its sides equal.

22. *Define a Square; a Diagonal.*

A Square is a quadrilateral having its sides equal and its angles right. A Diagonal of a polygon is a straight line joining two vertices, except, of course, two consecutive vertices, which are joined by a side.

The Altitude of any quadrilateral having parallel sides is the distance between parallels. Then either of these is called the *base*, and sometimes the two are called the bases. The altitude of a parallelogram may be either of the two distances.

23. *What is the standard measure of surfaces?*

The square. That is, the unit of area is a square having for its side the unit of length.

It is used because of its simplicity. It has the same length throughout its breadth, and the same breadth throughout its length; and the length and breadth are equal.

24. *What is the Pythagorean Theorem?*

The square on the hypotenuse of a right-angled triangle is equivalent to the sum of the squares on the sides that contain the right angle.

This theorem, discovered by Pythagoras, is known as the 47th Proposition, that being its number in the First Book of Euclid's Elements. The Pythagorean Theorem and the theory of similar triangles are the basis of Trigonometry.

25. *Define a Segment of a circle; a Sector.*

A Segment of a circle is the part cut off by a secant or chord. A Sector of a circle is the part between two radii and the arc intercepted by them.

26. *Meaning of "Rectification of the Circumference"; of "Squaring of a Circle"?*

The Rectification of a curve consists in finding a straight line of the same extent. The Quadrature or Squaring of a Circle consists in finding an equivalent rectilinear figure.

27. *What is a Diedral?*

A Diedral is the figure formed by two planes which meet. It is also called a *diedral angle*. The planes are its *faces* and the intersection is its *edge*.

28. *What is meant by Parallelism?*

Parallelism consists in the identity of the directions of lines, or of a line and a plane, or of planes. A Parallel Line and Plane are such that the line is parallel to a line in the plane; that is, the plane has directions which are the same that the line has.

29. *What is a Triedral?*

A Triedral is the figure formed by three planes meeting at one point. The point where the planes and intersections all meet is called the *vertex* of the triedral. The intersections are its *edges*, and the angles formed by the edges are its *faces*.

A triedral that has one rectangular diedral is called a *rectangular triedral*. If it has two, it is *birectangular;* if it has three, it is *trirectangular*. A triedral that has two of its faces equal is called *isosceles;* if all three are equal it is *equilateral*. *Supplementary triedrals* are two triedrals in which the faces and diedrals of the one are respectively the supplements of the diedrals and faces of the other. *Symmetrical triedrals* are two triedrals whose elements are respectively equal, but arranged in reverse order.

30. *What is a Polyedral?*

A Polyedral is a figure formed by several planes that meet at one point. The vertex, edges, and faces are defined, as those of a triedral. A triedral is a polyedral formed by three planes.

A polyedral is called *convex*, when every diagonal plane lines within the figure; otherwise it is called *concave*.

31. *What is a Polyedron?*

A Polyedron is a solid, or portion of space, bounded by plane surfaces. Each of the surfaces is a *face*, their intersections are *edges*, and the points of meeting of the edges are vertices of the polyedon.

A *Diagonal* of a polyedron is a straight line joining two vertices that are not in the same face.

A *Diagonal Plane* is a plane passing through three vertices that are not in the same face.

32. *Define a Tetraedron.*

A Tetraedron is a polyedron having four faces.

The *Altitude* of a tetraedron is the perpendicular distance from one face to the opposite vertex. This face is called the *base*, and the vertex is called the vertex of the tetraedron.

33. *What is a Pyramid?*

A Pyramid is a polyedron having for one face a polygon, and for the other faces triangles whose vertices are at one point.

The polygon is the *base* of the pyramid, the triangles are its *sides*, and their intersections are the lateral edges of the pyramid. The vertex of the polyedral is the vertex of the pyramid, and the perpendicular distance from that point to the plane of the base is its *altitude.*

34. *What is a Prism?*

A Prism is a polyedron which has two of its faces equal polygons lying in parallel planes, and the other faces parallelograms.

The Altitude of a Prism is the perpendicular distance between the planes of its bases.

A Right Prism is one whose lateral edges are perpendicular to the bases.

A Regular Prism is a right prism whose base is a regular polygon.

A Parallelopiped is a prism whose bases are parallelograms.

35. *What is a Cube?*

A Cube is a rectangular parallelopiped whose length, breadth and altitude are equal. Then a cube is bounded by six equal

squares; its vertices are trirectangular triedrals; and its edges are of right diedral angles.

36. *What is a Cone?*

A Cone is a solid described by the revolution of a right-angled triangle about one of its sides as an axis. The other side describes a plane surface, a circle, having for its radius the line by which it is described.

The plane surface of a cone is called its base. The opposite extremity of the axis is the *vertex*. The altitude is the distance from the vertex to the base, and the *slant height* is the distance from the vertex to the circumference of the base.

37. *What is a Cylinder?*

A Cylinder is a solid described by the revolution of a rectangle about one of its sides as an axis. The sides perpendicular to the axis describe circles; the opposite side describes a curved surface.

The plane surfaces of a cylinder are called its *bases*, and the perpendicular distance between them its *altitude*.

38. *What is a Sphere?*

A Sphere is a solid described by the revolution of a semi-circle about its diameter as an axis.

The *center, radius,* and *diameter* of the sphere are the same as those of the generating circle. The spherical surface is described by the circumference. The halves of sphere are called *hemispheres*.

39. *Mention terms applied to Cones.*

A cone is said to be inscribed in a pyramid when their bases lie in one plane, and the sides of the pyramid are tangent to the curved surface of the cone. The pyramid is said to be *circumscribed* about the cone.

A cone is said to be *circumscribed* about a pyramid when their bases lie in one plane, and the lateral edges of the pyramid lie in the curved surface of the cone. Then the pyramid is *inscribed* in the cone.

40. *Mention terms applied to Spheres.*

A sphere is said to be *inscribed* in a polyedron when the faces are tangent to the curved surface; and the polyedron is *circumscribed* about the sphere. A sphere is *circumscribed* about a polye-

dron when the vertices all lie in the curved surface; and the polyedron is *inscribed* in the sphere.

A frustrum of a cone is said to be *inscribed* in a sphere when the circumferences of its bases lie in the surfaces of the sphere.

A *Great Circle* of a sphere is a section made by a plane through the center.

. A *Small Circle* of a sphere is a section made by a plane not through the center.

The *Poles* of a circle are the points where its axis pierces the spherical surface.

41. *Define terms pertaining to Spherical Surfaces.*

A *Lune* is the part of the surface of a sphere between two halves of great circles. That part of the sphere between the two planes is called a *Spherical Wedge.*

A *Zone* is a part of the surface of a sphere between the two parallel planes. That part of the sphere itself is called a *Segment.* The circular sections are the *bases* of the segment, and the distance between the parallel planes is the *altitude* of the zone or segment. A spherical *Sector* is the part of a sphere described by the revolution of a circular sector about a diameter of the circle. A *Spherical Polygon* is part of the surface of a sphere included between three or more arcs of great circles.

SECTION XI.

CIVIL GOVERNMENT.

1. *Define a State.*

A State is a community of persons living within certain limits of territory, under a permanent organization, which aims to secure the prevalence of justice by self-imposed laws.

2. *What is Government?*

Government is control.

Civil government pertains to the citizens of a state or nation. It is control by law, exercised by a state over its members.

3. *When is a state Sovereign?*

If all the laws of a state are self-imposed, that is, if there is no power outside its body of people which dictates to it in any way, the state is said to be *sovereign.*

The sovereignty of a state consists in the absolute right to control its own members, and in the absolute right to resist any interference in its affairs by any state.

4. *What are Laws?*

Laws are expressions of the controlling will, which become rules of action for the governed.

A law, to secure control, must be accompanied by a penalty, and a certainty that the penalty will be inflicted.

5. *Why is government a necessity?*

Society must organize itself permanently: first, to control the evil inclined and protect the weak, and then to devise and carry out plans for the common necessity and convenience. Government is a necessity of society, and society is a necessity of man's nature.

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6. *What constitutes the Government of a State?*

Those persons, more or less numerous, who directly exercise control over the members of the state. Thus, in the United States, the President and all officers under his control, Congress, and the courts of justice, together form the government.

There is a distinction between the state and the government. The former is the whole body of people organized for the purpose of control; the latter is that part of the whole body through which the control is exercised.

The state is supreme: the government is subordinate. The right to control rests primarily with the state; secondarily, with the government.

7. *How is authority to govern obtained?*

It is probable that in the early history of the world all governments held their power by the tacit consent of the state. A single man, having, in a superior degree, the elements of control, physical strength, and skill, courage, and sagacity, came to be recognized by a simple pastoral people as having authority over them. His children in their turn would become rulers; and thus hereditary kingship would come to exist. In many cases power has been seized by force, and the people, finding resistance useless, have yielded to the usurpation.

8. *What are the functions of government?*

To make laws, to interpret and apply them; and these functions call for three departments—legislative, judicial, and executive.

9. *Define Statute Law.*

Statute law includes all enactments made by legislative bodies, and promulgated by them as laws.

These are formed from time to time, as circumstances make them necessary. In process of time some become useless, and are repealed, or changed, or they remain on the statute book without force.

10. *What is the Unwritten Law?*

It consists of all those judicial decisions which have become authoritative through all the periods of the nation's history.

11. *What is "Common Law"?*

The term "common law," as used in England and the United

States, includes all that portion of the unwritten law of England that has not been set aside by statutes or by more recent decisions.

12. *Define the several forms of government.*

Absolute, in which the laws are made by one person, and interpreted and executed by officers responsible only to him. Limited, in which there is an hereditary executive, and a legislative department whose members are chosen periodically by the people, the judiciary being responisble directly to the sovereign. Representative Democracy, or Republic, in which both the chief executive and the members of the legislative departments are chosen periodically by the people.

There have been states in which all the functions of government were in the hands of a few people, self-appointed. Such a government is an Oligarchy. If a class of nobles rules the state, the government is called an Aristocracy.

13. *What is a Constitution?*

The law by which the state controls the government. It is the fundamental law, and all others must accord with it.

Constitutions are of two kinds: some are written instruments,—others are without definite form.

14. *How is the authority of government limited?*

By limiting the term of service of its members. When the people have this power of changing the government at their will, it becomes impossible for any usurpation of authority to continue.

15. *How is every state divided?*

Into two classes,—those who have a voice in public affairs, and those who have not; the voting and the non-voting. Those who have a voice in the conduct of public affairs are said to have political liberty.

The voice of a majority of those who vote is considered to express the will of the state.

16. *What are the three obligations of a good government?*

First, to secure justice to the members of the state; second, to promote the general welfare; third, to defend the state.

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17. *How is justice secured?*

By protecting every individual in his right to personal security, personal liberty, private property, and his own religious belief and worship.

It is the duty of government to care for the life, health, and reputation of its subjects.

Personal liberty is freedom to go and come, to assemble peaceably for discussion, to petition the government, and freedom of speech and of the press.

The right of property covers the acquiring, using, and disposing of property, time, and labor.

18. *How are these natural rights limited in society?*

First, by a regard to the right of others; second, by the right of the government to take property for public purposes. This right of the government exists as the right of taxation, and right of eminent domain.

19. *What is civil liberty?*

It is the enjoyment of one's natural rights in society. It is liberty under the law. These rights may be forfeited by the commission of crime.

20. *How does the government promote the general welfare?*

By securing justice, by executing measures of public utility, and by fostering the industries of the state.

It is the duty of the government to provide for the education of the people; it may compel children to attend school; it should care for the general culture of the people. It is a duty of the government to defend the state.

21. *Give a summary of the nature and duties of citizenship.*

(1) A citizen is a member of the state. (2) He may be native or naturalized. (3) He is bound to support the government by obeying its laws. (4) He may disobey a law which violates his conscience, but he must suffer the penalties of disobedience. (5) He is bound to support the government with his money, and by his service if necessary to its defense. (6) Voting is a duty, and suffrage is a right.

22. *What are the principal executive officers of each state?*

In each state the people elect a governor, a lieutenant-governor, a secretary, a treasurer, an auditor, an attorney general, and a superintendent of public instruction.

23. *What are the Qualifications of a Governor?*

In Indiana the Governor must have been a citizen of the United States and a resident of the state for five years, and must have attained thirty years of age; in Illinois he must have been a citizen of the United States and of the state for five years, and must have attained thirty years of age; in Michigan he must have been a citizen of the United States for five years, and a resident of the state for two years, and must have attained thirty years of age; in Wisconsin he must be a citizen of the United States and a legal voter in the state; in Iowa he must be a citizen of the United States, a resident of the state for two years, and must have attained thirty years of age; in Minnesota he must be a citizen of the United States, a resident of the state for one year, and must have attained thirty-five years of age; in Ohio no qualifications are stated in the Constitution.

24. *What are the powers and duties of the Governor?*

(1) He is required to give information and advice to the Legislature upon matters pertaining to the interests of the state, and he may call special sessions of the two houses when, in his judgment, the public interests require it.

(2) He is commander-in-chief of the military forces of the state, having full power respecting their instruction and discipline. He may call out the troops and lead them in case of insurrection and invasion, and may order out such portions as may be necessary to suppress riots, and to aid in enforcing the laws.

(3) He has power to pardon offenses against the state after persons have been convicted of the same. This power does not usually extend to cases of impeachment, or of treason.

(4) He appoints notaries public, and members of various boards and commissions when authorized to do so by the Legislature.

(5) In general, it is his duty to superintend the administration of state business, and to see that the laws are executed.

25. *What are the duties of the Lieutenant-Governor?*

He is the presiding officer of the Senate. In case the chair of the Governor is vacant by reason of death, or absence from the state, or otherwise, the Lieutenant-Governor performs the duties of the Governor, and has all the powers which the Constitution confers upon that officer.

26. *What are the chief duties of the Secretary of State?*

To keep a record of the official acts of the executive and legislative departments; to attest the signature of the governor on commissions and proclamations; to keep the laws of the state and publish them; to receive and keep the returns of state and national elections; to receive and keep reports of corporations organized under the general laws of the state.

27. *Define the duties of the State Treasurer.*

He receives all money accruing to the state from taxation or otherwise; keeps all notes, bonds, and other securities which are the property of the state; and pays out such sums as the auditor draws his warrant for.

28. *What are the duties of the State Auditor?*

He is to examine all accounts and demands against the state, and to draw his warrant upon the state treasurer for the payment of such as are just. He also superintends the collection of dues to the state; examines the accounts of the treasurer; and reports to the Legislature, with suggestions, the financial condition of the state.

29. *Define the duties of the Attorney General.*

He is to prosecute and defend in the Supreme Court all actions in which the state is a party; to prosecute and defend any action when directed to do so by the Governor or Legislature; to advise and assist the subordinate prosecuting officers of the state; to give legal information and advice, when requested to do so, to the Legislature, and to any of the executive officers of the state.

30. *What are the duties of State Superintendent of Schools?*

To examine into the condition of the public schools of the state, and report thereon to the Legislature; to attend institutes and other meetings of teachers; to prepare blanks for, and to preserve statistics from, the local school officers; to supervise the school fund; to distribute the school laws and other documents for the use of school officers.

31. *What is the business of the Supreme Court of a state?*

To decide questions of law that come before it in review or correction of the proceedings of inferior courts.

32. *What is the jurisdiction of the Circuit or District Courts?*

They have original jurisdiction in all civil actions where the matter in dispute exceeds the jurisdiction of justices of the peace, and appellate jurisdiction in all civil actions that have been tried before the inferior courts. They also have original and appellate jurisdiction in all criminal actions, except those minor ones over which some of the inferior courts may have exclusive jurisdiction.

33. *Mention some of the inferior courts.*

Court of Common Pleas, Probate Court, Municipal Courts, Justices of the Peace.

34. *What are the objects of the Constitution of the United States?*

This is stated in the brief preamble: "We, the people of the United States, in order to form a more perfect union, establish justice, insure domestic tranquillity, provide for the common defense, promote the general welfare, and secure the blessings of liberty to ourselves and our posterity, do ordain and establish this Constitution for the United States of America."

35. *What are the requisite qualifications of a U. S. Representative?*

(1) He must be at least twenty-five years of age. (2) He must have been at least seven years a citizen of the United States. (3) When elected, he must be an inhabitant of the state.

36. *What are the special powers of the House?*

(1) To present articles of impeachment. (2) To originate all bills for raising revenue, though the senate may amend these.

37. *How are United States Senators chosen?*

They are chosen by the Legislature of the state. The members of each House, on the same day, vote *viva voce* for a Senator. On the next day the two Houses meet in convention, and if the same person has received a majority of all the votes cast in each House he is declared elected. If no person has received such majorities, then the two Houses, sitting as one body, proceed to vote *viva voce;* and, if a majority of each House is present, the person who receives a majority of the votes cast is declared elected. If there is no choice on the first day they are required to meet and take at least one vote each day, until choice is made or the session closes.

38. *What are the qualifications of a Senator ?*

He must be at least thirty years of age; must have been at least nine years a citizen of the United States; and, when elected, must be an inhabitant of the state.

39. *What are the sessions of a Congress?*

Each Congress usually holds two sessions: one longer, beginning in December of the odd year, and continuing until the next mid-summer; a second, or shorter, beginning in December of the even year, and continuing until the 4th of March following, when the term of service of all the representatives and of one-third of the senators expires.

40. *What are the requisite qualifications of the President?*

(1) He must be a native citizen. (2) He must be at least thirty-five years of age. (3) He must have been for at least fourteen years a resident of the United States.

41. *What is the mode of electing the President?*

(1) The people of each state choose a body of men called Electors. The number of these is the same as the number of senators and representatives which the state sends to Congress.

(2) On the first Wednesday in December the Electors meet at the capital of their respective states, and vote by ballot for a President. The Electors make three lists, each containing the names of the persons voted for, and the number of votes for each. These lists are signed by all the Electors, and sealed; and a person is appointed by them to carry one list to the president of the senate at Washington; another is sent by mail, directed to the same officer; and the third is delivered to the judge of the U. S. court for the district in which the Electors meet.

(3) On the first Wednesday in February the two Houses of Congress meet as one body, and the president of the Senate opens the certificates; the votes are then counted by tellers appointed for the purpose; and the person having a number of votes equal to a majority of the whole number of electors appointed, is declared elected.

42. *What results if no candidate has a majority of electoral votes ?*

Then the representatives proceed at once to choose a president.

For this purpose two-thirds of the states must be represented. The voting is by ballot, and by states, each state having one vote; and a majority of the states is required for election. The choice of the house must be from the three persons having the highest number of electoral votes.

The balloting of the house may continue until the 4th of March ensuing; when, if there has been no choice, the vice-president assumes the duties of president.

43. *What is required when both offices become vacant?*

The law requires that electors shall be chosen in the states, and persons elected to fill the vacancies in the same way as in the regular elections.

44. *How is the Vice-President elected?*

When the electors vote for president, they also vote by distinct ballots for the vice-president. They make similar lists of the persons voted for, and send them with the others; and the votes are counted at the same time.

45. *What is the nature of the electoral voting?*

It is only a form. The people vote for the electors with the understanding that by so doing they are expressing their choice for president. All that the electors have to do is to record their votes for the persons previously agreed upon.

46. *What are the powers given to Congress for raising money?*

" Congress shall have power to *lay* and *collect* taxes, duties, imposts, and excises, to pay the debts and provide for the common defense and general welfare of the United States."

47. *Define direct taxes.*

Direct taxes include poll taxes, and taxes on land, houses, and other real estate.

48. *What are indirect taxes?*

Indirect taxes include duties, imposts, and excises.

Duties upon exports are prohibited. Duties upon imports are of two kinds. *Specific* duties are proportioned to the *quantity* of the article imported ; *ad valorem* duties are proportioned to the market value of the article in the country from which it comes, as shown by an invoice accompanying it. A duty of a dollar a yard on silk would be *specific;* a duty of forty per cent on silk would be *ad valorem.*

49. *Define a tariff.*

A schedule of dutiable goods, with the rate upon each, is called a tariff.

All duties are paid in gold by the importer. For convenience in collection, custom houses are established at different places on the sea coast, on the navigable rivers, and on the boundary line between the states and the Dominion of Canada.

50. *Name the officers of the chief executive departments.*

All the executive business is distributed among seven departments constituted by acts of Congress. The chief officers of these are as follows: Secretary of State, Secretary of the Treasury, Secretary of War, Secretary of the Navy, Secretary of the Interior, Postmaster General, and Attorney General. These officers constitute the President's Cabinet.

51. *Define the functions of the State Department.*

They are of two kinds: those relating to domestic affairs, and those relating to foreign relations of the government. It has the custody of the seal of the United States and affixes it to all state documents, with the signature of the secretary. It has the keeping of the laws of the United States, and promulgates them. Through this department the president corresponds with and instructs the consuls and diplomatic agents of the government, negotiates with foreign nations, and receives communications from their agents. Passports—that is, certificates of citizenship — are issued by this department to persons needing them for the purpose of foreign travel.

52. *Define the functions of the Treasury Department.*

It prepares plans for the management of the public revenue, and the improvement of the public credit; makes estimates of the revenue and expenditures, and suggests ways to increase the former and diminish the latter; receives and disburses all moneys coming to the government; superintends the collection of the revenue. It also has charge of the mints of the United States, of the coast survey, and of the erection and maintenance of light-houses and other safeguards for navigation.

53. *What are the functions of the War Department?*

It has charge of the army rolls and register, of military equip-

ments and supplies, of the transportation, pay, and subsistence of the troops; of military hospitals, arsenals, and armories; of the military academy, of military surveys, and of the signal service for the preparation and publication of weather reports.

54. *What are the functions of the Navy Department?*

It superintends the purchase, building, and repair of vessels; has the care of navy yards and docks; provides for the equipment of vessels and crews, and for the clothing, subsistence, health, and pay of officers and men; issues all orders, and receives reports; has charge of the naval academy, and of scientific expeditions to foreign countries.

55. *Define the functions of the Postoffice Department.*

It establishes postoffices; selects post routes; makes contracts for postal supplies, and for carrying the mails; appoints most of the postmasters, directs all, and receives reports from all; provides and distributes stamps, envelopes, and postal cards; has charge of the money order system.

56. *What are the functions of the Interior Department?*

It has the general charge and superintendence of public lands and public buildings, of pensions, of patents, of Indian affairs, of the census, of mines, of the bureau of education.

57. *What are the functions of the Department of Justice?*

At the head of this department is the Attorney General, who conducts suits in the Supreme Court in which the United States is a party, and gives legal advice, when requested, to the President and Congress, and heads of departments.

58. *Define the functions of the Department of Agriculture.*

The chief officer of this department is a commissioner; he is not a member of the cabinet. The department collects and publishes information respecting the various branches of agriculture. It seeks to discover new and improved varieties of vegetable products, and distributes seeds of these over the country.

59. *What is the relation of the states to one another?*

Every state must give full faith and credit to the public acts,

records, and judicial proceedings of every other state. It can not question the authority under which they are made, and it must give them full weight as precedents for judgments.

SECTION XII.

RHETORIC.

1. *What does Rhetoric comprehend?*

In its widest acceptation Rhetoric comprehends all good composition. In its narrowest sense, it is limited to persuasive speaking. As a science it investigates, analyzes, and defines the principles of good writing; as an art it enables us to apply these principles, or in other words, teaches us the best method of communicating our thoughts.

2. *To which of the useful arts does Rhetoric belong?*

As an art Rhetoric has been classed by some among the useful arts, the object of which is to aid or benefit mankind; by others, among the elegant arts, which aim simply to please. It seems, however, to partake of the nature of both, and may therefore, with propriety, be denominated a mixed art.

3. *What advantages result from the study of Rhetoric?*

First, it enables us to discern faults and beauties in the composition of others; and, secondly, it teaches us how to express and embellish our own thoughts, so as to produce the most forcible impression.

4. *As used in this country what does the term belles-lettres signify?*

In this country the term is generally used to denote polite literature, including criticism, taste, the pleasures of the imagination, etc.

5. *What is Taste?*

Taste may be defined as that faculty of the mind which enables

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it to perceive, with the aid of reason to judge of, and with the help of imagination to enjoy, whatever is beautiful or sublime in the works of nature and art.

Close attention to models of style are necessary to a full appreciation of the great works of literature.

6. *Show the difference between Taste and Genius.*

Taste consists in the power of judging; genius in that of creating. Genius includes taste; whereas the latter not only may, but generally does, exist without the former.

The term *genius*, as commonly used, signifies a natural talent or aptitude for excelling in any particular vocation.

7. *What are the sources of the pleasures of the imagination?*

The novel, the wonderful, and the picturesque.

8. *What is the principal source of the sublime?*

Might, or power, in a state of active exertion. The emotion is of a serious character, and when awakened in the highest degree, may be designated even as severe, solemn, and awful.

9. *What kind of style must be employed in the sublime?*

To give effect to the description of a sublime object, a clear, strong, concise, and simple style must be employed.

10. *What is Wit?*

Wit is that quality of thoughts and expressions which excites in the mind an agreeable surprise, not by means of anything marvellous in the subject, but merely by employing a peculiar imagery, or presenting in a novel and singular relation ideas remotely connected.

11. *In what four ways is Wit excited?*

(1) By degrading elevated things. (2) By aggrandizing insignificant things. (3) By representing objects in an unusual light by means of singular imagery. (4) By paronomasia, or play upon words.

12. *Define Humor.*

Humor consists, for the most part, in a representation of imaginary, short-lived, or over-strained emotions, which display

themselves preposterously, or so as to excite derision rather than sympathy.

The aim of humor is simply to raise a laugh. When there is an ulterior object,—that is, when it is sought by means of this laugh to influence the opinions and purposes of the hearer or reader,—then humor becomes *ridicule*.

13. *What are the figures of orthography?*

Mimesis consists in imitating the mispronunciation of a word, by means of false spelling, as, "Well, *zur*, I'll *argify* the topic."

Archaism consists in spelling a word according to ancient usage, as, "The *gret Kyng hathe*, every day, fifty fair *Damyseles, alle Maydenes*, that *serven* him *everemore* at his *Mete*."

14. *What are the figures of etymology?*

Aphæresis is the elision of a letter or letters from the beginning of a word, as, '*bove*, for *above*.

Prosthesis is the prefixing of a letter or letters to a word, as, *adown*, for *down*.

Syncope is the elision of a letter or letters from the middle of a word, as, *e'en*, for *even*.

Apocope is the elision of a letter or letters at the end of a word, as, *tho'*, for *though*.

Paragoge is the annexing of a letter or letters to a word, as, *vasty*, for *vast*.

Diæresis is the separation into different syllables of two contiguous vowels that might unite in a diphthong. This figure is usually indicated by placing two dots over the last of the separated vowels, as, *aëronaut*, instead of *æronaut*.

Synæresis is the condensing of two syllables into one, as, *walk'st*, for *walkest*.

Tmesis is the separating of the parts of a compound by introducing a word or words between them, as, what *way soever he turned*.

15. *What are the figures of syntax?*

Ellipis is the omission of a word or words necessary to the construction of a sentence, but not essential to its meaning, as, "[He] who steals my purse steals trash."

Pleonasm is the use of superfluous words, as, "The boy, oh! where was *he?*" "I know thee, *who thou art*."

Syllepsis is the construing of words according to the meaning they convey, and not by the strict requirements of grammatical rules, as, " Philip went down to the city of Samaria, and preached Christ unto *them*."

Enallage is the use of one part of speech, or one modification of a word for another, as, " They fall *successive*, and *successive* rise."

Hyperbaton is the transposition of words, as " He wanders earth around," for " He wanders around the earth."

16. *Name the figures of Rhetoric.*

Simile, Metaphor, Allegory, Metonymy, Synecdoche, Hyperbole, Vision, Apostrophe, Personification, Interrogation, Exclamation, Antithesis, Climax, Irony, Apophasis, and Onomatopœia.

17. *Illustrate the figures of Rhetoric.*

Simile: " Sorrow, like a cloud on the sun, shades the soul of Clessamour."

Metaphor:

> " Life is a river gliding free
> To that unfathomed, boundless sea,
> The silent grave."

Allegory: " Thou hast brought a vine out of Egypt: thou hast cast out the heathen, and planted it. Thou preparedst room before it, and didst cause it take deep root, and it filled the land. The hills were covered with the shadows of it, and the boughs thereof were like the goodly cedars."

Metonymy: " The sceptre shall not depart from Judah," *i. e.*, *Kingly power.*

Synecdoche: " The sea is covered with sails," *i. e., ships.*

Hyperbole: " They [Saul and Jonathan] were swifter than eagles, they were stronger than lions."

Vision: " Cæsar leaves Gaul, crosses the Rubicon, and enters Italy."

Apostrophe: " Death is swallowed up in victory. O death, where is thy sting? O grave, where is thy victory?"

Personification: " The sea saw it and fled."

Interrogation: " Doth God pervert judgment? or doth the Almighty pervert justice?"

Exclamation: " Oh! the depth of the riches both of the wisdom and the knowledge of God!"

Antithesis: " Though grave, yet trifling; zealous, yet untrue."

Climax: " Who shall separate us from the love of Christ ? Shall tribulation, or distress, or persecution, or famine, or nakedness, or peril, or sword ?"

Irony: " Cry aloud, for he is a god."

Apophasis: " I say nothing of the notorious profligacy of his character ; nothing of the reckless extravagance with which he has wasted an ample fortune ; nothing of the disgusting intemperance which has sometimes caused him to reel in our streets ; but I aver that he has exhibited neither probity nor ability in the important office which he holds."

Onomatopœia: As when we say *rat tat tat,* to denote a knocking at the door.

18. *Define Narration, Argument, Exposition, Speculation.*

Narration is the account of real or imaginary facts or events ; argument is the statement of reasons for or against a proposition, made with the view of inducing belief in others ; exposition consists in explaining the meaning of an author, in defining terms, setting forth an abstract subject in its various relations, or presenting doctrines, precepts, principles, or rules, for the purpose of instructing others ; speculation is the expression of theoretical views not as yet verified by fact or practice.

19. *What are the six leading divisions of Prose Composition?*

Letters, Narratives, Fiction, Essays, Theses or Argumentative Discourses, and Orations.

A Letter is a written communication on any subject from one person to another. Narratives are divided into Histories, Biographies, Obituaries, Voyages, Travels, and Anecdotes. Fiction consists in the narration of imaginary incidents. An Essay is generally applied to productions in which a writer briefly sets forth his views on the leading points connected with a subject, without pausing to consider them carefully or minutely. A Thesis, or Argumentative Discourse, is a composition in which the writer lays down a proposition, and endeavors to persuade others that it is true. The statements or reasons used for this purpose are called Arguments. An Oration is a discourse intended for public delivery, and written in a style adapted thereto.

20. *Define some terms of Poetical Composition.*

Verse is a metrical line of a length and rhythm determined by rules which usage has sanctioned ; a *Hemistich* is half a verse ; *Rhyme* is a similarity of sound in syllables which begin differently but end alike ; a *Distich,* or *Couplet,* consists of two verses rhyming together ; a *Triplet* consists of three verses rhyming together ; a

Stanza (often incorrectly called a *verse*) is a regular division of a poem, consisting of two or more lines, or verses; a *Foot* is a division of a verse consisting of two or three syllables.

21. *Define the principal varieties of Poetry.*

Epic Poetry is that which treats of the exploits of heroes.

Dramatic Poetry is closely allied to epic. Like the latter, it generally relates to some important event, and for the most part appears in the form of blank, or heroic verse.

Lyric Poetry is that variety which is adapted to singing and an accompaniment of the lyre or other musical instrument.

Elegiac Poetry treats of mournful subjects.

Pastoral Poetry depicts shepherd-life by means of narratives, songs, and dialogues.

Didactic Poetry aims to instruct rather than to please.

Satirical Poetry is that in which the weaknesses, follies, or wickedness, of men are held up to ridicule, or rebuked with serious severity.

SECTION XIII.

ALGEBRA.

1. *What is an Algebraic Quantity?*

An Algebraic Quantity is a quantity expressed in algebraic language.

2. *Name and define the two kinds of algebraic quantities.*

(1) Known Quantities are those whose values are given; when these are not expressed by figures they are represented by the leading letters of the alphabet, as a, b, c, d.

(2) Unknown Quantities are those whose values are to be determined; they are represented by the final letters of the alphabet, as w, x, y, z.

3. *Define Terms as used in algebra.*

The Terms of an algebraic quantity are the parts or divisions made by the signs $+$ and $-$. Positive Terms are those which have the plus sign. Negative Terms are those which have the minus sign.

The first term of an algebraic quantity, if written without any sign, is positive, the plus sign being understood. The sign of a negative quantity is never omitted.

4. *Define Similar and Dissimilar Terms.*

Similar Terms are terms containing the same letters, affected with the same exponents; the signs and coefficients may differ, and the terms still be similar.

Dissimilar Terms are those which have different letters or exponents.

$3x^2$ and $7x^2$ are similar; also $2md^2$ and $-5md^2$ are similar.
axy and ayz are dissimilar; also $3x^2y$ and $3x^3y^2$.

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5. *Define a Coefficient, also an Exponent.*

A Coefficient is a number or quantity prefixed to another quantity, to denote how many times the latter is taken. Thus, in $3x$ the number 3 is the coefficient of x, and indicates that x is taken 3 times. The figure which indicates how many times the root or factor is taken is called the *exponent* of the power. Thus, in the indicated product a^5, a is the root, a^5 is the power, called the 5th power of a, and 5 is the exponent of this power.

When no exponent is written over a quantity, the exponent 1 may always be understood.

6. *Name the classes of algebraic quantities.*

(1) A Monomial is an algebraic quantity consisting of only one term, as $3x$, or $-7xy$.

(2) A Polynomial consists of more than one term, as $x + y$, or $4a^2 - 3x + m$.

(3) A Binomial is a polynomial of two terms, as $a + b$, or $3x - z$.

(4) A Residual is a binomial, the two terms of which are connected by the minus sign, as $a - b$, or $4x - 3y$.

(5) A Trinomial is a polynomial of three terms, as $x + y + z$, or $7a - 3b^2 + d$.

A Homogeneous Quantity is one whose terms are all of the same degree, as $x^3 - 5x^2y + 3xyz$.

7. *Define Degree.*

The degree of a term is the number of its literal factors. Thus, x and $5y$ are terms of the first degree; a^2 and $4ab$ are terms of the second degree; x^3, $3x^2y$, $3xy^2$, and $4xyz$ are terms of the third degree.

8. *Repeat the Axioms which underlie all algebraic operations.*

(1) If the same quantity or equal quantities be added to equal quantities, the sums will be equal.

(2) If the same quantity or equal quantities be subtracted from equal quantities, the remainders will be equal.

(3) If equal quantities be multiplied by the same, or equal quantities, the products will be equal.

(4) If equal quantities be divided by the same, or equal quantities, the quotients will be equal.

(5) If a quantity be both increased and diminished by another, its value will not be changed.

(6) If a quantity be both multiplied and divided by another, its value will not be changed.

(7) Quantities which respectively equal the same quantity are equal to each other.

(8) Like powers of equal quantities are equal.

(9) Like roots of equal quantities are equal.

(10) The whole of a quantity is greater than any of its parts.

(11) The whole of a quantity is equal to the sum of all its parts.

9. *How are similar terms to be added?*

(1) When the signs are alike, add the coefficients and prefix the sum, with the given sign, to the common literal part.

(2) When the signs are unlike, find the sum of the positive and of the negative coefficients separately and prefix the difference of the two sums, with the sign of the greater, to the common literal part.

10. *How add polynomials?*

(1) Write the quantities to be added, placing the similar terms together in separate columns.

(2) Add each column, and connect the several results by their respective signs.

11. *What is algebraic subtraction?*

Subtracting any quantity consists in adding the same quantity with its sign changed.

12. *How operate in algebraic subtraction?*

Conceive the signs of the subtrahend to be changed, unite the similar terms as in addition, and bring down all the remaining terms with their proper signs.

13. *Name the uses of the parenthesis.*

(1) A parenthesis preceded by the plus sign may be removed, and the inclosed terms written with their proper signs. Thus:
$$a - b + (c - d + e) = a - b + c + e.$$

(2) Conversely: Any number of terms, with their proper signs,

may be inclosed by a parenthesis, and the plus sign written before the whole. Thus:

$$a - b + c - d + e = a + (- b + c - d + e).$$

(3) A parenthesis preceded by the minus sign may be removed, provided the signs of all the inclosed terms be changed. Thus:

$$a - (b - c + d - e) = a - b + c - d + e.$$

(4) Conversely: Any number of terms may be inclosed by a parenthesis, preceded by the minus sign, provided the signs of all the given terms be changed. Thus:

$$a - b + c - d + e = a - b + c - (d - e).$$

14. *What is the law of Coefficients? Of Exponents? Of Signs?*

(1) The coefficient of the product is equal to the product of the coefficients of the multiplicand and multiplier, as $a \times b = ab$. $5a \times 3b = 15ab$.

(2) The exponent of any letter in the product is equal to the sum of the exponents of this letter in the multiplicand and multiplier; since $a^4b^3 = aaaabbb$, and $a^3b^2 = aaabb$, we have $a^4b^3 \times a^3b^2 = aaaabbbaaabb = a^7b^5$.

(3) The signs $+$ and $-$, when prefixed to a multiplier, must be interpreted as follows: The plus sign before a multiplier shows that the multiplicand is to be successively added; and the minus sign before a multiplier shows that the multiplicand is to be successively subtracted.

When the two factors have like signs, the product is positive; and when the two factors have unlike signs, the product is negative. The product of an even number of negative factors is positive; and the product of an odd number of negative factors is negative.

15. *How may the product of two or more polynomials be indicated?*

By inclosing each in a parenthesis, and writing them one after another, with or without the sign $\times$, between the parentheses. Such an expression is said to be *expanded*, when the indicated multiplication has been actually performed, as, $(a + m) (a + d) = a^2 + am + ad + dm$.

16. *Repeat the three algebraic formulas for obtaining the products of certain binomial factors.*

(1) The square of the sum of two quantities is equal to the square of the first, plus twice the product of the first by the second,

plus the square of the second. Thus, $(a + b)^2 = (a + b)(a + b) = a^2 + 2ab + b^2$.

(2) The square of the difference of two quantities is equal to the square of the first, minus twice the product of the first and second, plus the square of the second. Thus, $(a - b)^2 = (a - b)(a - b) = a^2 - 2ab + b^2$.

(3) The product of the sum and difference of two quantities is equal to the difference of their squares. Thus, $(a + b)(a - b) = a^2 - b^2$.

17. *How find the coefficient and the exponent, respectively, in division ?*

(1) The coefficient of the quotient must be found by dividing the coefficient of the dividend by that of the divisor; and (2) The exponent of any letter in the quotient must be found by subtracting the exponent of this letter in the divisor from its exponent in the dividend. Thus, $24a^5 \div 6a^3 = \frac{24}{6}a^{5-3} = 4a^2$.

18. *What is the reciprocal of a quantity?*

It is the quotient obtained by dividing unity by that quantity. Thus, $\frac{1}{x}$ is the reciprocal of x; $\frac{1}{a-c}$ is the reciprocal of $a - c$.

19. *Define Equation. First Member. Second Member.*

(1) An equation is an expression of equality between two quantities. Thus, $x + y = a$.

(2) The first member of an equation is the quantity on the left of the sign of equality; and the second member is that on the right of the sign of equality.

20. *Define the unknown quantity of an equation.*

It is the letter to which some particular value or values must be given, in order that the statement contained in the equation may be true. And such value or values are said to *satisfy the equation.*

21. *Define the several kinds of equations.*

(1) A Numerical Equation is one in which all the known quantities are expressed by figures, as $3x^3 - x^2 + 2x = 17$.

(2) A Literal Equation has some or all of the known quantities expressed by letters, as $ax^2 - 3bx = 5d$.

(3) An Equation of Condition is one which must exist between

certain known or arbitrary quantities, in order that certain other equations may be true. Thus, the two equations,

$$x + c = 5a$$
$$x - c = a$$

can not both be true at the same time, unless $c = 2a$.

(4) An **Identical Equation** is one in which the two members are the same algebraic expressions, or are reducible to the same. Thus, $a^2 - 3x = a^2 - 3x$

$$x^2 - a^2 = (x + a)(x - a)$$

(5) A **Simple Equation** is an equation of the first degree.

(6) A **Quadratic Equation** is an equation of the second degree.

(7) A **Cubic Equation** is one of the third degree.

The Degree of an equation is denoted by the greatest number of unknown factors occurring in any term.

22. *What is a Problem?*

A Problem, in Algebra, is a question requiring the values of one or more unknown quantities from given conditions.

There are two classes of problems which may be solved by the use of a single equation: (1) Questions referring to a single unknown quantity, (2) Questions referring to two or more unknown quantities, so related that when one is known the other may be determined directly by the given conditions.

23. *Give a general rule for the solution of any problem requiring but one equation.*

(1) Represent one of the unknown quantities by some letter or symbol, and then from the given relations find an algebraic expression for each of the other unknown quantities, if any, involved in the question.

(2) Form an equation from some condition, expressed or implied, by indicating the operations necessary to verify the value of the unknown quantity represented by the symbol.

(3) Reduce the equation thus derived.

24. *What is an Indeterminate Equation?*

One which is satisfied by an infinite number of values of the unknown quantities.

Every single equation containing two unknown quantities, is indeterminate.

25. *What is Elimination?*

Elimination is the process of combining equations in such a

manner as to cause one or more of the unknown quantities contained in them to disappear.

There are four principal methods of elimination: (1) By addition and subtraction; (2) By comparison; (3) By substitution; (4) By indeterminate multipliers.

26. *What is the General Solution of a problem?*

It is the process of obtaining a formula which shall express, in known terms, the values of the unknown quantities in the given problem, or in any problem of its class.

27. *What are plus and minus in algebra?*

They are not *symbols of operation* merely, but also symbols of relation, serving to distinguish quantities in opposite conditions or circumstances.

28. *Show that the value of a fraction depends simply upon the relative values of the numerator and denominator.*

(1) $\dfrac{a}{o} = \infty$ (infinity). That is, a finite quantity divided by zero is an expression for infinity.

(2) $\dfrac{a}{\infty} = 0$. That is, a finite quantity divided by infinity is an expression for zero or nothing.

(3) $\dfrac{0}{b} = 0$. That is, zero divied by a finite quantity is an expression for nothing or zero.

(4) $\dfrac{0}{0} =$ an indeterminate quantity. That is, zero divided by zero is a symbol for indetermination.

29. *What is the law of power in involution?*

(1) All powers of a positive quantity are positive.
(2) The odd powers of a negative quantity are negative, but the even powers are positive.

30. *What is true as to exponents in all algebraic operations?*

If two powers of the same quantity be given, then the exponent of their product will be equal to the algebraic sum of the given exponents, and the exponent of their quotient will be equal to the *algebraic difference* of the given exponents.

31. *What are the two methods of indicating evolution?*

(1) By the radical sign; thus, $\sqrt[3]{a}$ denotes the *cube root* of a. When no index is written, 2 is understood; thus, $\sqrt{x}$ denotes the square root of x, and signifies the same as $\sqrt[2]{x}$.

(2) By fractional exponents; thus, the cube root of a, or a^1, is written $a^{\frac{1}{3}}$, and the cube root of a^2 will be $a^{\frac{2}{3}}$.

A *Surd* is a root which can not be exactly obtained. An *imaginary* root is one which is known to be impossible on account of the *sign* of the given quantity.

32. *What is a radical quantity?*

It is a root merely indicated, either by the radical sign or by a fractional exponent, as $\sqrt[3]{a}$, $\sqrt[3]{a-b}$, $c(a+b)^{\frac{1}{3}}$, $m\sqrt[n]{x^2-y^2}$.

The degree of a radical quantity is denoted by the radical index, or by the denominator of the fractional exponent. Thus, $\sqrt{a}$, $(a-b)^{\frac{1}{2}}$ are radicals of the 2d degree; $\sqrt[3]{x^2-y}$, $a^{\frac{1}{3}}b^{\frac{1}{3}}$ are radicals of the 3d degree; $\sqrt[n]{ac}$, $(x+y)^{\frac{1}{n}}$ are radicals of the nth de-degree. Similar radicals are those in which the same quantity is affected by radical signs having the same index. Thus, $4\sqrt[3]{a^2+b}$, $-\sqrt[3]{a^2+b}$, and $7(a^2+b)^{\frac{1}{3}}$ are similar radicals.

33. *Define rationalization in Algebra.*

The process of clearing a quantity of radical signs by multiplication, is called Rationalization.

34. *Define a Radical Equation. A Quadratic Equation.*

A Radical Equation is one in which the unknown quantity is affected by the radical sign.

A Quadratic Equation is an equation of the second degree, or one which contains the second power of the unknown quantity, and no higher power, as $3x^2 = 48$, and $ax^2 - 2bx = c$.

A Pure Quadratic Equation is one which contains the second power only of the unknown quantity, as $3x^2 - 7 = 20$.
An Affected Quadratic Equation is one which contains both the first and the second powers of the unknown quantity, as $2x^2 - 3x = 12$.

35. *What is true in the solution of particular problems involving quadratics?*

That in certain cases both roots of the equation will answer

the conditions of the problem, while in other cases only one of the roots is admissible.

36. *Define the several terms of proportion.*

The Terms of a proportion are the four quantities which are compared.

The Antecedents are the first terms of the two couplets; or the first and third terms of the proportion.

The Consequents are the second terms of the two couplets; or the second and fourth terms of the proportion.

The Extremes in a proportion are the first and third terms.

37. *What is the Binomial Theorem?*

The Binomial Theorem has for its object the development of a binomial with any exponent, into a series. This theorem is expressed by an equation, called the Binomial Formula.

38. *What is the Method of Indeterminate Coefficients?*

It consists in *assuming* the required development in the form of a series with unknown coefficients, and afterward determining the values of the coefficients by means of the known properties of identical equations.

39. *What is the Reversion of a series? The Summation of a series?*

The Reversion of a series is the process of finding the value of the unknown quantity in the series, expressed in terms of another unknown quantity.

The Summation of a series is the process of obtaining a finite expression equivalent to the series.

40. *Define a Recurring Series.*

A Recurring series is one in which a certain number of consecutive terms, taken in any part of the series, sustain a fixed relation to the term which immediately succeeds. Thus:

$$1 + 4x + 11x^2 + 34x^3 + 101x^4 + \ldots$$

is a recurring series, in which if any two consecutive terms be taken the product of the first by $3x^2$ plus the product of the second by $2x$ will be equal to the next succeeding term.

41.   *What is the Differential Method?*

It is the process of finding any term of a regular series, or the sum of any number of terms, by means of the *successive differences* of the terms.

42.   *What is the Logarithm of a number?*

It is the exponent of the power to which a certain other number called the *base*, must be raised, in order to produce the given number.   Thus, in the expression $a^x = b$, the exponent x is the logarithm of b to the base a.

A System of Logarithms consists of the logarithms of all possible numbers, according to a given base.

The Index or Characteristic of a Logarithm is the integral part; and the Mantissa is the fractional part of a logarithm.

SECTION XIV.

POLITICAL ECONOMY.

1. *What is Political Economy ?*

Political Economy, strictly speaking, is state economy as opposed to family economy or individual economy.

2. *What is wealth?*

Wealth is anything appropriated by labor or discovery which contributes to our *weal,* or which gratifies a desire.

3. *What is meant by production ?*

Any change effected in an object, by which it is rendered in any way better adapted to gratify human desire, is called Production.

We do not produce the objects themselves nor their qualities. We can only modify or change these objects. All such modifications are called productions, and the modified objects are called products.

4. *What is consumption ?*

Consumption is the opposite of production. In its most general sense, it is the destruction of any quality in an object which fits it for human use in that form.

All consumption involves production; for nothing is absolutely destroyed,—it only undergoes a change of form. But much may be wasted,— called *unproductive* consumption.

5. *What is exchange ?*

Exchange is trading off articles which any one has for those which another has. When the exchange is direct between the articles themselves, it is called *exchange in kind,* or *barter;* but when the article is exchanged for money it is called a *sale.*

6. *Of what does capital consist?*

Capital may be said in general to consist of money, of land, of instruments of labor, and means of support and comfort.

It is the object of political economy to point out the principle of an equitable division of the results of production between capital and labor.

7. *What principle does political economy assume as its basis?*

That men in their business affairs are governed by *selfishness;* that every man will aim so to dispose of his labor and its products as to promote in the highest degree the objects of his desires, and will endeavor to attain any end with the least possible amount of irksome labor. From it follow the laws of value and price, and on it rests our whole monetary and industrial fabric.

8. *What may constitute articles of wealth?*

Not only natural objects of material growth may constitute articles of wealth, but those of spiritual growth also, such as a sermon, a plea, advice, instruction, etc., which are produced by the natural organs under the inspiration of the spirit within.

9. *Where are the materials of wealth found?*

They are all furnished by nature. They are found in the earth, the water, and the air.

10. *In what does the real value of an article consist?*

The intrinsic value or utility of an article consists in what it *avails* to gratify some desire or want of our nature.

The value of articles is proportionate to the labor bestowed upon them.

11. *What determines supply and demand?*

The views and opinions of men. The regular wants of each community, and hence of the world at large, demand a given supply of the various articles of necessity and comfort, and consequently of the labor required in producing them.

12. *What is the effect of greater profits in any kind of business?*

Greater profits in any kind of production make wages higher in that business, and hence attract labor to it; while for the same reason, labor is repelled from the production of articles which are relatively lower than other articles, compared with the cost of production.

13. *What is the effect of sagacity on profits?*

Sagacity anticipates the new wants which are sure to arise in the progress of things, and devises modes of meeting them. It discovers new and useful qualities in objects, and 'cheap and convenient methods of rendering them available.

14. *What must the price of an article vary with?*

The price of an article being its representative in money, that price, of course, must vary with the value of money.

15. *What does capital include?*

Capital includes everything employed in production except the labor.

16. *Name the kinds of capital employed in production.*

(1) The material upon which the laborer works; (2) the instruments with which he works; (3) the food and shelter by which the health and strength of the laborer are maintained; (4) the mature products of each department of industry.

17. *What are specimens of unproductive capital?*

Money hoarded, land lying waste, goods locked up in storehouses, machinery unemployed, and buildings unoccupied, are all unproductive capital, or mere articles of wealth.

18. *What is fixed capital?*

It is that form of capital which has one definite and fixed use, and which serves its purpose in production without any material change, as houses, lands, stores, ships, factories, machinery, wagons, and all instruments, tools, and implements employed in any art.

19. *What is circulating capital?*

Circulating capital is the material worked upon.

Thus, what is a raw hide in the hands of the butcher, becomes leather in the hands of the currier, and shoes in the hands of the shoemaker. In all these forms it is circulating capital; but when it comes to be worn as an article of dress, it becomes fixed capital, since in this form it merely assists the individual in production.

20. *To what form of capital does money belong?*

Money, as the circulating medium, ever passing from hand to hand, must belong to circulating rather than fixed capital.

21. *What is the necessity for a division of labor?*

It is impossible for each man to perform every kind of labor, and produce all the articles which he needs. Besides the want of ability in man, there is an equal want of means and capabilities for all kinds of production in every place.

22. *What are the advantages of a division of labor?*

(1) Saving of time; (2) gain in skill arising from the attention being exclusively confined to a single operation; (3) the employment of cheap labor; (4) employment being given to more persons, the cost of products is reduced.

23. *How have machines come into use?*

As labor is divided, the whole attention of the operative is directed to a single operation, and his whole study is to see how this can he performed the most easily and effectually. By the repeated performance of the operation and long attention to it improvements in the tools for performing it naturally suggest themselves to him. And improved tools being made by the operatives in the different parts of the process, these are at length combined in one or several machines, by which the whole process is performed almost without the aid of man.

24. *What are the advantages of inanimate over animate agents?*

(1) Inanimate agents can be made to work in a far smaller space than animate agents; (2) inanimate agents work continuously and with great regularity and precision, while animals must have intervals of rest, often become restive under the hand of their driver, and flag in the performance of their task; (3) although the original expense of engines and the expense of maintaining them is great, yet it is much smaller than that of purchasing and maintaining the number of animals adequate to perform the same work.

25. *What may we do by the aid of machinery?*

By means of machinery we may give to the motion produced by the agent a perpendicular, a horizontal, or a rotary direction, as is seen in the trip-hammer, the railroad locomotive, and the steamboat. Or we may exert all the power upon a single point, as in forging anchors or rolling iron; or else we may distribute it

over a wide space and among a variety of operations. By machinery we may accumulate power for a sudden stroke, as in the pile-driver, or for a gradual and regular evolution through a longer or shorter period, as in the clock or watch.

26. *What is the effect of these aids to production on human happiness?*

Labor-saving machinery greatly diminishes the cost of articles, and hence increases the demand for them, and consequently for the labor required in producing them; since the number of purchasers of any article of common use increases rapidly as it comes within the reach of those of small means, who are always vastly more numerous than those of large means. Besides when articles are cheap they are put to new uses. Hence, the use of labor-saving machinery is a blessing to all classes.

27. *What is the right of property?*

The right of property is to hold and use as one pleases—in an innocent way—what is his own. Any violation of this right is injustice, and must interfere materially with the development of industry and the accumulation of property. One will not labor for that of which he may at any moment be unjustly deprived.

28. *What is the design of taxes.*

They are designed for the support of the government under which one lives, and, when used legitimately, are applied only to that purpose.

29. *What are the kinds of taxes?*

The schedule of taxes on articles imported into any country is commonly called a *tariff*, and the taxes themselves go by the name of *duties*. These duties are either *specific* or *ad-valorem*, according as they are so much on the pound, yard, gallon, etc., or such a percentage on the estimated value of the article imported·

The most important division of taxes is into *direct* and *indirect*. Taxes are said to be direct when levied directly on the individual who is to pay them as a tax on one's poll, or on his income, property or estate. But indirect taxes are levied in the form of an *excise* on articles produced within the country, or of a duty on those imported from abroad, which is ultimately to be paid by the consumer.

30. *On what principle should the revenues of a country be raised?*

The necessary revenue of a country should always be raised by

the simplest and most natural principles, and on as few articles as possible, that business in general may be free and unencumbered.

31. *What is the effect of true frugality?*

It enables the possessor of property to employ all that is not really for his good in the legitimate business of producing more property, thus giving employment to honest industry ; or to bestow it as a gift upon worthy objects and institutions designed to promote the higher interests of society.

32. *What are to be considered in determining one's business?*

We should first take into the account our own qualifications and aptitudes. It is all important that every man should hit upon that kind of business which will promote his happiness and success. The nature of the employment should also be considered. Habits of honest industry promote frugality and sober views of life, which are the surest guaranty of ultimate success.

33. *What naturally lead to different kinds of employment?*

The different dispositions, tastes, and abilities of men, and varying wants, demanding different employment.

34. *What causes fluctuations in business?*

As production is the basis of business, business must vary as this varies. Some seasons are more favorable to agriculture and manufacturing pursuits than others, and hence more favorable to business generally.

35. *What would be the consequences if there were no accepted medium of exchange?*

If there were no accepted medium of exchange,—*i. e.*, some article which all are ready to receive and pay out at a fixed value for other articles,—the only way in which one could obtain what he wants for what he has to spare, would be to look up some one who has what he wants, and at the same time wants what he has.

This mode of exchange, since the articles themselves are directly exchanged one for the other, is called *exchange in kind*, or *barter*. Since this mode of exchange is inconvenient, men have readily agreed to receive some representative article for all others at certain rates.

36. *What brings about foreign exchanges?*

Our wants, being numerous, can not all be supplied by articles produced in any one country.

37. *Illustrate a bill of exchange.*

If A in Boston owes B in New York, $1,000, and C in New York owes D in Boston the same sum, then A can purchase of his fellow-citizen D his claim against C (called a bill of exchange), and send it to his creditor B, who can collect it of his fellow-citizen C, and the whole will be settled without the transportation of any money, it having been reduced to a mere exchange in kind. In the same way the exchanges between different countries are settled.

38. *Upon what does the amount of money required in any community depend?*

Upon the extent of the business to be transacted and the extent of territory over which it is spread.

39. *What medium of exchange is necessary?*

A certain amount of gold and silver is necessary to transact the business of a community with convenience. If paper money be substituted for it and accepted as the medium of exchange, the same number of dollars will be required, and no more. If there be any more put in circulation its value will depreciate in the same proportion, so that the *value* of the whole will be no greater, however much increased in volume.

40. *What is the value of paper money?*

Its chief value is conventional, arising from its being agreed upon or rejected as the circulating medium. The value of a paper dollar depends partly upon its being needed as a medium of exchange, and partly upon the prospect of its being ultimately redeemed in real value.

41. *Why are gold and silver always in demand?*

Because they have great uniformity in value. Being comparatively rare products, beautiful in appearance, and easily wrought

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into beautiful forms, they are the universal money of all commer-
cial nations.

They are thus fitted to be the basis for the paper circulation of any
country, and they are the only articles which are precisely fitted for this, re-
quiring only that the different pieces be coined and stamped by the govern-
ment according to their real value, that this may be readily known.

42. *How does currency differ from pure credit?*

Although, in one sense, currency is itself a form of credit, yet,
when a legal tender, or redeemable in specie, it pays debts, which
pure credit does not, but simply acknowledges a debt to be paid
at some future time.

43. *What paper serves the same purpose as currency?*

Checks, drafts on banks, and other drafts payable at sight, are
received as cash because they represent cash, and can be turned
into it at any moment.

But the real forms of credit do not serve this purpose, only as far as they
pass from hand to hand in the actual payment of debts.

44. *What is the object of banks?*

The object of banks is to concentrate at convenient points, and
thus to utilize in the highest degree, that portion of the capital of
a community which is in the form of money.

The lender and the borrower are brought together by the establishment
of the bank. The lender intrusts the loaning of his money to the directors
of the bank, who make it their business to learn the pecuniary responsi-
bility of borrowers, and exact good security in the form of indorsers, etc.

45. *What constitutes a bank of deposit?*

If the coin of a town or a neighborhood is simply collected to-
gether and deposited in a bank for safe-keeping, this constitutes
what is called a *bank of deposit.*

In such a case the depositor is credited with the coin in the books of the
institution, and if at any time he wishes to make any payment to another,
he simply draws an order, or " check," on the bank and hands it to him,
which perhaps he in turn deposits with the bank, and the cashier transfers
the amount in his books from the former owner to his credit.

46. *What are banks of discount?*

The bank, finding the depositors disposed to let their deposits
remain in its vaults, takes the liberty of loaning the coin to others,
who also, perhaps, will let it lie there, and simply draw checks
against it to make payments with, the money on which, in many

cases, is not actually drawn out, but left on deposit again. The bank is now called a bank of discount or loan.

47. *What are banks of circulation?*

The directors of the bank prepare notes or "bills," which obligate the bank to pay on demand, in coin, the sum they represent. These bills, signed by the president and cashier of the bank, have more of a public character, and hence will be much more generally current than the private checks of individuals. Banks under this form are called banks of circulation.

48. *How are the bill holders secured under our present system of banking?*

By the bonds deposited with the United States Treasurer at Washington. If the bank fails to redeem its bills these bonds are pledged to redeem them.

49. *What is the propriety of taking interest on money loaned?*

Loaning money is a temporary exchange, and, like all exchanges, is made for the sake of profit. It is perfectly proper and legitimate to take such a return for the use of money. If the exchange is made on the one side for profit, it is equally so on the other. If the man who loans the money does so for the sake of interest, the one who receives it willingly pays this interest for the sake of its use.

50. *Why is one entitled to something for the use of land?*

If land may be rightfully appropriated and become one's property, then something may be demanded for the use of it, the same as for the use of money or any other property. It costs the owner something, and gives him a certain advantage in production, which of course he will not relinquish without some consideration. Rent, therefore, is the consideration given for the temporary use of the beneficial qualities of land, and must generally be in proportion to the valuable qualities of the land rented.

51. *What is the relation of profit and wages?*

All products are the result of the coöperation of labor and capital. The laborer practices self-denial in submitting to irksome labor, and so does the capitalist by foregoing the use of his cap-

ital in self-indulgence and employing it in further production. The remuneration of the laborer is called *wages,* while that of the capitalist is called *profit.*

The profits of any business, then, should be equal to the interest on the capital employed, taking into account the risk incurred, together with a suitable compensation for superintendence. The wages, on the other hand, must be sufficient, at least, to support the laborer for the time being, together with those dependent upon him, and should also include some provision for sickness, old age, etc.

52. *What determines the rate of wages?*

The price of labor, like the price of anything else offered in the market, is determined by the principle of supply and demand.

SECTION XV.

DESCRIPTIVE BOTANY.

1. *Describe the parts of a leaf.*

A leaf, in its most highly developed state, consists of three parts: The flattened portion is called the *lamina*, or *blade;* a narrower portion, connecting the blade with the plant, is termed the *petiole*, or *leaf-stalk;* and a third portion, at the base of the petiole, which is either in the form of a sheath, or consists of two little leaf-like appendages, called *stipules*.

2. *What is meant by the venation of the leaf?*

The lines, fine and coarse, that are seen running through the blades of leaves are called *veins;* and the various ways in which they are distributed are spoken of generally as the *venation* of the leaf.

3. *Name and describe leaf-margins.*

Entire—smooth and even edge; *serrate*—uneven edge, like the teeth of a saw; *retroserrate*—when the teeth point toward the base; *dentate*—when the teeth are sharp, without pointing in any particular direction; *crenate*—when the teeth are rounded; *bicrenate*—if the teeth are twice rounded.

Margins are also *crisped* or *curled, wavy* or *undulated*. When the incisions of a leaf-margin are deep, the divisions of the blade so formed are called *lobes*, and the spaces between the lobes are called *sinuses*, or *fissures*.

4. *Describe the blades of some leaves.*

If the blade be divided nearly to the base or midriff, the partings are termed *partitions*, and the leaf is *partite;* if it is divided quite to the base, the parts are called *segments*, and the leaf is said to be *dissected*.

According to the number of lobes, partitions, or segments, leaves are said to be fifid, trifid, bipartite, bisected, trisected, etc.

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5. *What terms are applied to the apex of a leaf-blade?*

When the apex is rounded, it is said to be *obtuse*, or *blunt;* when obtuse, with a broad, shallow notch in the middle, it is *retuse.* If this notch is sharp, it is *emarginate.*

6. *Describe the figures, or shapes of leaves.*

Oblique—unequally developed on the two sides of the base, or midrif; *linear*—when narrow, and of nearly the same breadth at the base and apex, with parallel margins; *acerose*, or *needle-shaped*—if ending in a sharp, rigid point; *awl-shaped*—when very narrow, and tapering from the base to a fine point; *lanceolate*—when broadest at the center, and three or more times as long as broad, tapering both ways; *oval*, or *elliptical*—when longer than broad, and slightly acute at the base and apex.

Cordate or heart-shaped leaves have an acute apex, with their broad, round base hollowed out into two lobes. When a cordate base is joined with a rounded apex, the leaf is reniform, or kidney-shaped.

7. *What is a compound leaf?*

A leaf with more than one blade is a *compound* leaf, and each of its blades is called a *leaflet.*

8. *Describe palmately compound leaves.*

Palmately compound leaves are said to be *binate, two-fingered,* or *bifoliate,* when two leaflets spring from a common point; *ternate* or *trifoliate,* if they have three leaflets similarly placed; *quadrinate, four-fingered,* or *quadrifoliate; quinate,* or *five-fingered; septenate,* or *seven-fingered;* and *multifoliate,* if there are more than seven leaflets.

9. *Name the two classes of roots.*

When the fibers (in mass) of the root grow downward from the base of the stem, the root is called *fibrous.* When the root seems a continuation of the stem it is a *tap-root.*

10. *What are herbs?*

Herbs are plants having stems that die down to the surface of the ground every year. If the root dies as well as the stem, the plant is called an *annual;* but if it lives and sends up a flowering stem the second year, and then dies, it is a *biennial;* while if the root lives on from year to year and only the stem dies, the plant is *perennial.*

11. *What is found in the angle made by the leaf with the stem?*

A bud. Botanists call this angle a *leaf-axil*, and its bud an *axillary bud*.

Buds at the free end of stems and branches are called *terminal buds*. The points on a stem at which leaves are given off are called *nodes*, and the spaces between the nodes are *internodes*.

12. *How are leaves arranged in the bud?*

Either in a *valvate or imbricate* manner. The arrangement is valvate when the edges of adjacent leaves barely touch each other. It is imbricate when the edges overlap each other.

13. *What terms are applied to stems?*

The stem of an herb is named a *caulis;* that of a tree, a *trunk;* that of grasses, a *culm;* and that of tree-ferns and palms, a *caudex.*

14. *Meaning of inflorescence?*

The way flowers are placed upon plants is called their *inflorescence.* When only one flower grows upon a stem the inflorescence is *solitary;* but if several flowers grow from the same stem, it is *clustered.*

15. *Describe the parts of green flower-leaves.*

The outer circle of green flower-leaves is named the *calyx.* The inner circle, of delicately colored leaves is named the *corolla.* When both circles have the same color, they take the name of *perianth.* Next inside the corolla come the *stamens,* and within these the *pistil.* If there is but one circle of flower-leaves it is called a *calyx,* whatever its color.

Each leaf of a calyx is called a *sepal.* Each leaf of a corolla is called a *petal.*

16. *Describe the petals of a corolla.*

When the petals of a corolla are distinct from each other, so that one can be pulled off without disturbing the rest, it is a *polypetalous* corolla. When the petals are more or less grown together, so that if you pull one the whole corolla comes off, it is a *gamopetalous* corolla.

17. *What is a symmetrical flower?*

Any flower that has the same number of parts in each of its

circles is symmetrical; and even if some of the circles have just twice, or three or four times, as many as others, it is still symmetrical.

These kinds of symmetry are described as *binary, ternary, quaternary,* and *quinary.*

18. *What are complete and incomplete flowers?*

A *complete* flower consists of calyx, corolla, stamens, and pistil. If any one or more of these flower-circles is absent the flower is *incomplete.*

19. *What are essential and what protecting organs of flowers?*

The stamens and pistil of flowers have been called *essential* organs, because seeds can not be formed without their presence. As the calyx and corolla cover and nourish these they have taken the name of *protecting* organs.

20. *What is a perfect flower?*

A perfect flower has both the essential organs; while, if one of these be absent it is *imperfect;* and if both are wanting, it is said to be *neutral.*

A *staminate* flower has no pistil. A pistillate flower has no stamens. Staminate flowers are said to be *sterile,* because they do not produce seed; they are also spoken of as *male* flowers. Pistillate flowers are said to be fertile, because they may bear seed; they are also called *female* flowers.

21. *What is meant by cohesion in botany? By adhesion?*

It is used for the growing together of parts with their fellows, as of petals with petals, carpels with carpels.

Adhesion means the growing together of different floral whorls.

22. *Meaning of plant-characters?*

All unchanging features of plants are *plant-characters.* A plant is an assemblage of characters, and the description of a plant is but a list of its characters.

These resemblances of character among plants are called their *affinities.*

23. *Name and define the parts of stamens.*

The Anther-Lobe is the cell which holds the pollen. Connective, a continuation of the filament which unites the two lobes of

the anther. Valves, the sides of an anther-lobe. Line or Point of Dehiscence, the opening through which the pollen escapes.

24. *Name the kinds of these openings through which the pollen escapes.*

Vertical or Longitudinal Dehiscence,—when the anther opens by a slit along its length to emit the pollen.

Transverse,—when the line of dehiscence is across the anther.

Porous,—when the anthers emit the pollen through little pores.

Valvular,—when a portion of the anther is lifted up to emit the pollen.

25. *Describe the attachment of filament to anther.*

Anthers are *innate*, or *basifixed*, when the filament runs directly into the base of the connective; *actuate*, or *dorsifixed*, when the filament runs up the back of the anther, joining the connective in such a way that the anther is hung in front of it; *versatile*, if the filament is attached by a slender apex to the middle of the anther, the ends of which swing freely up and down.

26. *Describe the forms of Filaments.*

Filiform filaments are threadlike, as the name denotes, but strong enough to support the anther.

Subulate filaments taper like an awl.

Capillary filaments are hair-like, and too slender to support the anther.

Dilated filaments are flattened out.

Petaloid filaments resemble petals in form, and bear the anther at the summit.

Bidentate, or *Bicuspid*, filaments are toothed at the summit or at the base.

27. *Describe the structure of Pollen.*

The pollen-grain is generally composed of two membranes, or coats, filled with a thick liquid substance containing minute grains, which is its essential portion. The outer coat is frequently marked with bands, lines, and grooves, or covered with bristling points. The inner coat is very thin, and swells when wet.

Extine is the outer coat of a pollen-grain, usually with openings, or very thin in certain places.

Intine is the inner coat of a pollen-grain, very thin, tough and elastic, often seen protruding through holes in the extine.

Fovilla is the rich protoplasmic liquid contained within the intine.

Pollinia are pollen-grains cohering in masses.

28. *What are the general features of stamens?*

Stamens are said to be *exserted* when they extend beyond the corolla. When they are not so long as the corolla, they are said to be *included*.

The entire whorl of stamens is called the *andrœcium*. When the filament is wanting, the anther is described as *sessile*. When the anther is wanting, the stamen is said to be *sterile*. Converging stamens are said to be *connivent*.

29. *What are the names applied to certain distinctions among pistils?*

A compound pistil consists of several united carpels, and is *syncarpous*. A simple pistil consists of only a single carpel, and is *apocarpous*. A multiple pistil consists of several *distinct* carpels, and is also *apocarpous*.

30. *Describe the structure of a pea or bean pod.*

The soft, small bodies in the young pods are called *ovules*. The ripe, full-grown contents of the mature pod are *seeds*. Pod and contents form the *fruit*. The fruit of a plant is its ripened ovary.

31. *What is fruit?*

The ripened ovary, with its contents, is the fruit of plants. Whatever adheres to the ovary also becomes part of the fruit.

32. *What are the classes of fruit?*

Indehiscent Juicy Fruits, as the berry, orange, lemon, squash, apple, pear, peach, cherry.

Indehiscent Dry Fruits, as wheat, barley, oats, etc., nuts, elm fruit.

Dehiscent Fruit, as any dry fruit, whether simple or compound, which may properly be called a pod.

Multiple, Collective, or Confluent Fruits, are formed by the union of many separate flowers into one mass.

33. *What is said of seeds as to form and surface?*

Seeds may be globular, ovoid, reniform, oblong, cylindrical, top-shaped, angular, etc. Some seeds are small and fine like sawdust; others are flattened and bordered.

The surfaces of seeds may be smooth, striated, ribbed, furrowed, netted, and tubercular. Seeds are said to be *definite* when few and constant in number; *indefinite* when numerous and variable; *solitary* when single in the ovary, or in a cell of the ovary.

34. *What are the parts of a seed?*

Seed-Coat, or Integument,—the shell around the outside of a seed.

Body, Kernel, or Nucleus,—the substance within the seed-coat.

35. *What names are given to the two parts of a seed?*

Embryo,—the young plant contained in a seed.

Albumen, Endosperm,—the material in which the embryo is embedded.

36. *What are the parts of the embryo?*

Cotyledon,—the bulky first leaf or leaves of the embryo, more or less formed before the growth of the seed begins.

Radicle,—the lower, or root end, of the embryo.

Plumule,—the terminal bud, the upper end of the embryo.

37. *Name the parts of flower-heads.*

Involucre,—the outer green circle of a flower-head, often mistaken for a calyx.

Scales,—the bracts forming the involucre of a flower-head.

Florets,—the flowers of a flower-head.

Ray Florets,—the outer petal-like florets of a flower-head.

Disk Florets,—the inner florets of a flower-head.

38. *What are Compositæ plants?*

Dandelions, daisies, dahlias, thistles, etc., are composed of many florets, inclosed in a calyx—like involucre. Plants of this kind are named Compositæ, from their compound, or composite nature.

39. *What is the character of the Cruciferæ?*

The plants of this order bear flowers with a cruciferous corolla. Mustard, horse-radish, turnip, cabbage, pepper-grass, etc., are familiar examples.

40. *What are Umbelliferæ plants?*

The plants of this family blossom in umbels. They are found in groves, thickets, plains, marshes, and waste places. The carrot, parsnip, parsley, celery, etc., also belong to this class.

41. *What plants belong to the order Labiatæ?*

Herbs, with square stems and opposite aromatic leaves; flowers, with a more or less two-lipped corolla, didynamous or diandrous stamens, usually with diverging anthers; ovary, deeply four-lobed, on a fleshy disk, four-celled, each cell with one erect ovule forming in fruit four little seed-like nutlets around the base of the single style, in the bottom of the persistent calyx. Seeds with little albumen. Stamens inserted on the tube of the corolla. Stigma forked. Flowers axillary, chiefly in cymose clusters. Leaves, usually dotted with glands, containing a pungent, volatile oil.

42. *Describe the Coniferæ order of plants.*

Trees or shrubs; the wood abounds in a resinous juice. Leaves scale-like, almost evergreen. Flowers monœcious, or diœcious, destitute of calyx and corolla. Stamens one, or more, forming a sort of loose ament. Fertile flowers usually in aments, consisting of open carpellary scales, sometimes solitary and destitute of any form of carpel. Fruit a strobile, or cone.

43. *What are the characters of the Orchidaceæ plants?*

Leaves simple, entire, parallel-veined. Flowers very irregular, Stamens consolidated with the style into a column. Pollen sometimes granular and powdery, but more commonly cohering in wax-like masses. Fruit a three-ribbed, three-valved capsule.

44. *Describe the Gramineæ order of plants.*

Perennial herbs with fibrous roots. Leaves entire, usually narrow, alternate, with the sheath split from one node down to the next. Flowers in spikes, racemes, or panicles, usually perfect. Stamens commonly three. Fruit, a caryopsis.

45. *What belong to the flowerless plants?*

Ferns,—dense, green patches of plants, apparently all leaf and and no stem; Mosses; Fungi,—as the common mushroom, or toadstool.

MENTAL AND MORAL PHILOSOPHY.

1. *What is Mind?*

The Mind is that which thinks, feels, and wills.

2. *How many and what departments of the Mind do its operations indicate?*

Three: The thinking or knowing part, called the *Intellect;* the feeling or emotional part, called the *Sensibilities;* and the part which puts forth volition, known as the *Will.*

A *Mental Faculty* is the mind's power of doing something or of putting forth some mental activity. The mind has as many faculties as there are distinct forms of this mental activity. Metaphysicians do not agree upon the exact number of mental faculties, some holding that attention and consciousness are distinct mental powers, while others maintain that these are only conditions which accompany all forms of mental activity.—*Dr. Raub.*

3. *What does the Intellect include?*

The Intellect includes a number of faculties—*Perception, Memory, Imagination, Understanding,* and *Reason* or *Intuition.*

The *Understanding* embraces several distinct forms of mental activity, known as *Abstraction, Classification, Generalization, Judgment,* and *Reasoning.*

4. *What do the Sensibilities include?*

The Sensibilities include the emotions, the appetites, and the desires.

These are also subdivided by some authors into animal and rational.

5. *Define the Will.*

The Will is the executive power of the mind.

Each of these mental powers has its special work to perform, not only in acquiring knowledge, but also in the matter of securing proper culture and development.

6. *What is the object of Mental Culture?*

The object of Mental Culture is the fullest development and highest activity of the faculties of the mind.

In cultivating the mind, therefore, the aim should be to attain the three ends—*culture, knowledge*, and *efficiency.*

7. *What is the natural order of the development of the mind?*

First in order is the education of the Intellect.

8. *How is the Intellect developed?*

By the acquisition of knowledge.

9. *How is knowledge acquired?*

Knowledge is first acquired, in youth, through the Senses.

The first efforts in education should be directed to systematize observation and the first subjects of study are very naturally the facts in the physical sciences.—*Sypher.*

10. *Define Memory?*

Memory is that faculty of the mind by which we retain and recall knowledge.

11. *Define Recollection.*

It is the power by which that which lies in the mind is awakened.

12. *Define Imagination.*

It is the power by which the mind holds up before itself the images which are called up by recollection.

13. *Define Understanding.*

It is the faculty by which the relations of things to each other are determined.

14. *Define Reason.*

It is the faculty through which the ultimate and universal principles are ascertained.

Following this order, which is the order in which these faculties are developed, Memory must be exercised in conjunction with the Senses and Perception. It is the storehouse into which the Perceptive faculties carry all the facts obtained through the Senses. Calling up for inspection the things which are thus stored in the mind gives exercise to the Memory; holding them up to view affords exercise to the Imagination. The Understanding takes up the pictures of the Imagination, receives what Recollec-

tion has called up from the Memory, which has been stored by the opera-
tion of the Senses, and determines the relations of all the parts to each other
as causes and effects. It classifies in accordance with perceived relations.
It places facts together as links in a chain.—*Sypher.*

15. *What are the two great sources of knowledge?*

The Senses and the Reason.

16. *What is the knowledge derived through the Senses called?*

Empirical Knowledge—the knowledge of experience.

17. *What does this include?*

It includes all that we know through the Senses—seeing, hear-
ing, touching, tasting, smelling—and through emotional experi-
ences.

18. *What is the knowledge derived by Reason called?*

Rational knowledge; ideas of space, of time, of distance, the
truths evolved by mathematical calculations, ideas of the abso-
lute and the infinite, are attained through processes of reasoning,
and can not be reached by experience.

19. *State the methods of acquiring knowledge.*

There are two methods of dealing with the products of the
Senses and of the Reason.
(1) By Induction.
That is particular phenomena may be taken up and the process
may be conducted so as to find the general laws, which unite these
into a harmonious system.
(2) By Deduction.
That is a general truth may be presented and the process will
then be to find the original elements which enter into its compo-
sition.

The inductive process is synthetic and the deductive is analytic. By syn-
thesis the parts are constructed into a whole; by analysis the whole is sepa-
rated into its parts.

20. *State the law of the operation of the faculties.*

The mind proceeds in its search after truth by means of obser-
vation. All the higher operations of investigation had their be-
ginning in small and simple processes in the mind of the child.

The mind rises through all the parts of a science or subject, observing at

every step the logical order of combination. When knowledge comes in this connected order, its acquisition gives strength to the memory, because the truths so learned are stored away in the mind that the presentation of one induces the recollection of another, and thus innumerable incidents in the range of observation call up long trains of thought. This often brings before the mind in moments of leisure and in the hour of play the knowledge that was acquired through much toil and effort.

21. *State the importance of gaining knowledge through logical methods.*

Knowledge gained through logical methods becomes food for all the faculties of the mind, affording them exercise and recreation, the free indulgence of which induces culture.

22. *What is the consequence of a failure to follow this natural order?*

Without the development of the intellectual faculties in their natural order and in harmonious proportion, the attainment of that higher and more complete culture involving the full growth of all the faculties of the mind which gives power and efficiency, can not be attained.

23. *How can the intellect be developed methodically?*

By the proper exercise of all the faculties in their natural order.

Antecedent to all methodical education must be a desire for knowledge. There must be a mental appetite to be gratified before mental food can be administered with profit. As the physical system is clogged and injured by administering food when it is not wanted—when there is no appetite demanding it—so all efforts at cramming the mind with mental pabulum will result in injury.—*Sypher.*

24. *What is the natural process of educating?*

The first knowledge of the child is acquired by observation. The first effort of the teacher should be to encourage and systematize observation.

25. *How does this process affect the powers of the mind?*

It brings order to the perceptive faculties; utilizes the stores of and strengthens the Memory; brings order and strength to the Recollection; utilizes Imagination, and exercises Judgment.

26. *What can you say regarding the education of the Emotional Nature and the Will?*

To give bodily vigor and intellectual ability, without any moral foundation to the character, is to give an education, not only wanting in completeness, but in balance; an education which may be mischievous both to the individual and to society.

The emotions need to be gradually brought more or less under control; the sense of duty awakened; the moral judgment formed; wrong tendencies corrected; and the recognition of the beauty of right and order, of nature and art, established; while the Will—developed by exercise, enlightened by experience, and stimulated by proper motives—assumes the guidance of the whole nature, and steers it in accordance with fixed principles of right and duty.—*Landon.*

27. *What must be taken into consideration in training to right action?*

(1) The *initiative power*, that is, the *motives*.

(2) The *legislative power*, that is, the action of the *moral intelligence and judgment*, which decides whether an action is right or wrong.

(3) The *administrative power*, that is, the power of *Will*, whereby we adhere to and carry out the decisions arrived at by the intellect and the conscience.

(4) The *reflective power*, whereby we recognize the result or consequence of the action whether in accordance with our previous judgment or not, and which exercises influence on succeeding actions.

28. *What is a moral action?*

It is the voluntary action of an intelligent agent, who is capable of distinguishing between right and wrong, or of distinguishing what he ought, from what he ought not, to do.

29. *How does this principle apply in the school-room?*

It relates to the rights and duties of persons connected with the school.

30. *What are the ends sought in school-government?*

(1) To find means of preventing disorder in school. (2) To find means of correcting disorder in school. (3) To find means of inducing pupils to discharge their duties of their own accord.

31. *How may disorder in school be prevented?*

By judicious regulations.

The most judicious regulations will not prevent all disorder. What can not be prevented must be corrected. It is not simply enough to secure good order in a school either by preventing bad order or correcting the same. Pupils must be trained to discharge all of their duties properly and of their own accord.

32. *Generalize the means of preventing disorder*

Disorder in school is owing to certain causes which can gener-

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ally be removed before any bad effects result.   These causes may be generalized as follows:

(1) Unsuitable accommodations.
(2) Unqualified teachers.
(3) Bad management.

33. *How shall disorder in school be corrected?*

(1) By the punishment of those who offend.
(2) By the pardon of those who repent.

34. *How shall pupils be induced to discharge their duties of their own accord?*

To discuss this subject fully would be to open the whole field of Moral Culture.   We can give only a few words on the subject here. Before a pupil can discharge his duties of his own accord, he must—

(1) Know what is right.
(2) Feel the claims of the right.
(3) Will to do the right.

The teacher must therefore direct the pupil to three kinds of moral training, viz: Moral knowing, Moral feeling, and Moral willing.

APPENDIX.
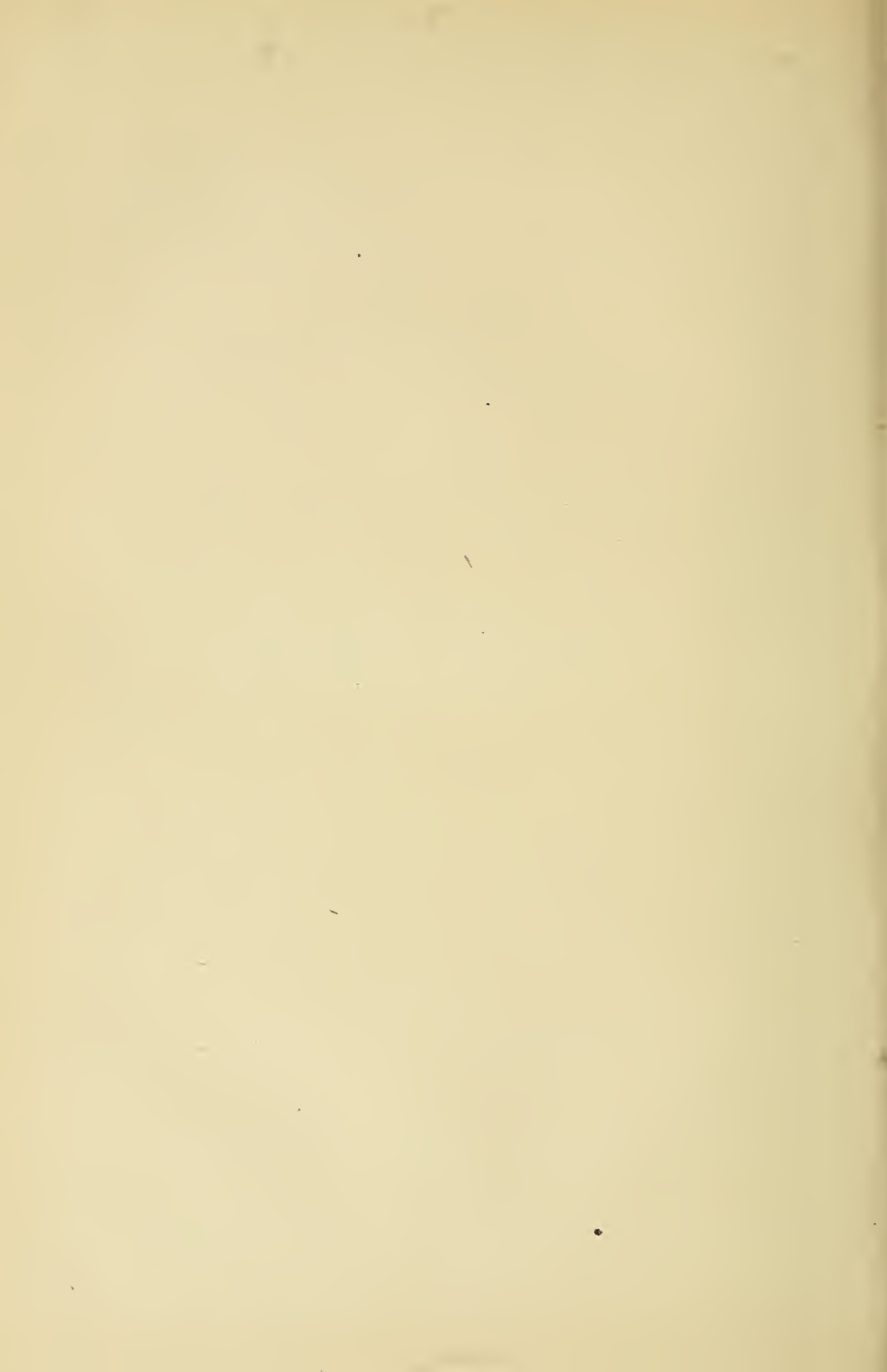
SCIENCE IN OUR PUBLIC SCHOOLS.

C. E. McVEY.

Of the importance of science in our schools there can be no question. None is urged by the normal teacher. The only dissenting voice heard in the land are the croakings of some old pedagogues, whose means for knowing and being known are somewhat circumscribed, and whose knowledge consists of a little grammar, a little arithmetic, and but little of any thing else.

The only question that can be urged is a want of time; and yet I think too frequently we have too much time; at least we spend unnecessary time on comparatively unimportant branches. The teacher too frequently thinks that he must make his pupils faultless reciters; that he must cram into their minds a certain amount of certain prescribed text-books, and to do this he must not only consume the six hours of the day, but must compel even the smaller pupils to use a certain portion of their time at home, which should be given to home influences, to physical culture and the sports of childhood. The younger pupils, under no consideration, should be compelled to do more than can be done during the regular school hours, and on the older pupils, unless in extreme cases,

no extra amount of regular school work should be imposed. Employment for these is necessary; but let it be in the form of recreation. Let it be in investigating some of the truths of natural science. Let it be in a direction which will widen their field of observation, and make them intelligent men and women. I have known teachers who have thought their work accomplished when they had taught simply that which they were compelled to teach, and the result was, pupils going out from these teachers felt that their education was finished, and, like the young lady from boarding-school, had nothing to do but exercise their various accomplishments. Far from having such impressions made on the minds of our pupils, we should have them feel that their education has just begun, and as they go out into the world, the very air they breathe, the stones and pebbles over which they walk, the weeds at their feet, and the earth itself, are all unfolding to them the book of nature, bidding them read and be wise. The true teacher can do this. He who has the best interests of his school at heart; he who would make broad and intelligent thinkers of his pupils, avails himself of every opportunity to present, not only the text-book, but to draw out the minds of his pupils in other directions, to have them hunger and thirst, as it were, to understand the workings of nature with which they are surrounded.

I know of no better incentive to prevent tardiness than for the teacher to take up some of the more simple truths of the sciences, such as Philosophy, Botany, and Geology, and by devoting a few moments of the time allotted to general exercises to a discussion of

these, in such a manner as to arouse an interest, to awaken dormant faculties, to teach observation—in a word, to open new channels of thought and investigation in the direction of those things which before have been entirely void of interest.

In Natural Philosophy, let the teacher begin with the subject of pneumatics, because the principal form of matter treated under this subject is that with which the pupils have come in contact every moment of their existence, and yet one of which they have a very vague and indefinite idea, as the teacher will learn if he but examines his pupils with regard to their conception of the atmosphere. In presenting this, let the teacher show by experiment (and this is the only way they will be comprehended) that air is something; that it is transparent, compressible, elastic, etc. In suggesting these experiments it is presumed that the teacher is provided with no apparatus, except such as can be improvised by any country teacher. If, however, the teacher feels disposed to purchase apparatus he will be amply repaid for all expenditures he may make in this direction.

First, let it be shown that air occupies space. This may be done by inverting a tumbler and thrusting it into a vessel of water. It will add interest to the experiment if, at the same time, the principle of the diving-bell is illustrated. This may be done by fastening a doll in the bottom of the tumbler before inverting. It will be noticed on removing the doll from the vessel that the water has not come in contact with it. Air being a form of matter, the water can not occupy the same space with it at the same time.

The compressibility and elasticity of air may be shown in the boy's pop-gun. These may also be illustrated by partially filling a bottle with water, and by perforating the cork, cause a pipe-stem to pass almost to the bottom of the bottle. Now compress the air in the bottle by blowing through the stem. On removing the mouth, the elasticity of the air causes the water to pass up through the stem, when a miniature fountain will be produced. The pressure of air, its tendency to restore an equilibrium of pressure when disturbed, the pneumatic paradox, and almost all the properties of air may be shown by simple apparatus, such as the teacher can readily provide. The length of this article only permits me to suggest a few of the many ways in which this branch of the subject may be presented; whatever may be said of this can with equal force, however, be said of all others with regard to the apparatus to be used and their importance in the education of our youth.

Botany may be made interesting by the teacher bringing before the school in these exercises of which I have spoken, the different parts of the plant, showing the office that each part performed in the great plan of vegetation. Let the pupils learn to distinguish the different whorls of the flower, to tell which are essential and which are not; to classify the parts of the whorls, and to name and point them out when called upon by the teacher. They should be able to name the parts of a leaf, the bark, the stem, the roots, etc. They should understand the meaning of the terms absorption, circulation, and elaboration. They should be able to point out the difference between a

plant and an animal, and to show how mutually dependent the one is to the other. Let the teacher explain the use of the different plants found in the locality where he is teaching, showing that even the despised weed is not made in vain. The pupils, especially the boys, may be induced to gather fine collections of wood, planing the specimens to regular forms, and naming them with their common and technical names. The girls may gather collections of seed and name them in a similar manner.

In close connection with Philosophy and Botany, the subject of Geology should be presented. This may be done by the teacher bringing into the presence of his school some common mineral or fossil, that the pupils noticed, but in which heretofore they have had no interest, because

> "A fossil by a river's brim
> A common fossil was to them;
> And it was nothing more."

But now, through the agency of the teacher, by his showing that the history of these minerals and fossils is very intimately associated with that of the earth itself, and that they have been so interesting to scientific men as to command each a separate name, their curiosity is thoroughly excited, and the teacher will soon find them gathering into their cabinet of curiosities the minerals and fossils of that particular geological formation.

I have thus far referred to but three of the sciences that should be taught in their elementary forms in our common schools. I might add to these Human Physiology, Zoölogy, and a little Chemistry, such as man-

ufacturing and manipulating a few of the more common gases.

Physical Geography should be taught in its broadest sense; and in the presentation of all of these sciences the pupils should know, so far as possible, by exercising their own intellects, and by a personal contact, that the thing is so. Let teachers, as I have said before, present these truths whenever the opportunity is given. Let them teach their pupils to observe, to investigate, to think for themselves, and the charge will not be laid to the schools, of which they are teachers, that they are simply "schooling machines," but will be considered in their true sense "educational forces."

In conclusion, I can not forbear quoting from Huxley. Speaking of the importance of science in our schools, he says: "No boy or girl should leave school without possessing a grasp of the general character of science, and without having been disciplined, more or less, in the methods of all the sciences, so that when turned into the world to make their own way, they shall be prepared to face scientific problems, not by knowing at once the condition of every problem, or by being able at once to solve it, but by being familiar with the general rules of scientific thought, and by being able to apply the methods of science in the proper way when they have acquainted themselves with the conditions of the special problem."

HOW TO TEACH PHYSIOLOGY.

A. KATE HURON.

[This article is taken from an old number of *The Normal Teacher*.]

The study of Physiology is frequently pronounced dry and repulsive, simply because teachers neither know how to teach nor pupils how to learn.

I well remember to have commenced the study, by endeavoring to commit to memory the first three chapters of Cutter's work, embracing " General Remarks," " Structure of Man," and " Chemistry of the Human Body." The process was accompanied by appropriate swayings of the body to and fro, and by the sing-song chant that is always so interesting on such occasions. I succeeded in " saying my lesson," for memory at that time was less treacherous than now; but the distinction between osmazome and hydrogen, potash and dermoid tissue, fibrin and apparatuses, and so on through the list, was somewhat vague; and my attachment for the subject was commensurate with my fondness for " big words."

Where was the error? Clearly in taxing the memory with that which was neither deducible from a process of reasoning, nor associated either by laws of similarity and contrast, or evident co-ordination and

subordination.   It has been truly said that " *Theoretically*, the brain is like a target on which every idea that is evolved makes a permanent impression which no subsequent impression can thoroughly destroy; *practically*, it is rather like a series of sieves by which thoughts are sifted through various stages below and on the borders of consciousness and recollection, while only the coarser and larger grains are retained where they can be used when needed."   Therefore that system of teaching which appeals to the memory alone will certainly fail to educate.

Since order and system universally prevail throughout all departments of science, it is only by discovering the proper relations that a knowledge of a branch can be truly had.   And a subject so important and necessary to our success and happiness as a knowledge of ourselves ought never to be neglected or made repulsive.

The following method of teaching Physiology by outline is submitted as suggestive of a systematic way of presenting the subject.   While the outline is not exhaustive, and perhaps not the best, it can be so modified and enlarged as to meet the requirements of any grade of learners.   To those who understand the exponential system of outlining it needs no explanation; to others it may be necessary to say that the large figures indicate co-ordination, the exponents, subordination; the degree of the exponent showing the degree of subordination; thus, the exponent 1 indicates the first set of subordinates, 2 is subordinate to 1, 3 to 2, 4 to 3, etc.

MAN.

  1^1. Natures.

    1^2. Spiritual.

    2^2. Physical.

      1^3. Systems.

        1^4. Osseous.

          1^5. Divisions.

            1^6. Head.

              1^7. Location.

              2^7. Divisions.

                1^8. Cranium.

                  1^9. Single bones.

                    1^{10}. Occipital.

                      1^{11}. Location.

                      2^{11}. Form.

                      3^{11}. Articulations.

                        1^{12}. Parietals.

                        2^{12}. Temporals.

                        3^{12}. Sphenoid.

                        4^{12}. Atlas.

                    2^{10}. Frontal.   [above.

                      1^{11}. Same subordinates as

                    3^{10}. Sphenoid. Same subordi-

                              [nates.

                    4^{10}. Ethmoid.   "   "

                  2^9. In pairs.

                    1^{10}. Parietal.   "   "

                    2^{10}. Temporal.   "   "

                3^9. Use.

              2^8. Ear.   [points as for cranium.

                1^9. Name the bones and give same

              3^8. Face.

     1^9. Single bones.

       1^{10}. Name them and give above points.

     2^9. In Pairs.   [nates.

       1^{10}. Names of bones and proper subordi-

   2^6. Trunk.

    1^7. Single Bones.

     1^8. Names, etc.

    2^7. In Pairs.

     1^8. Names, etc.

   3^6. Upper Extremities.

    1^7. Humerus, etc.

   4^6. Lower Extremities.

  2^5. Structure.

   1^6. Microscopical.

   2^6. Chemical.

   3^6. Mechanical.

  3^5. Articulation.

   1^6 Elements, etc.

 2^4. Muscular.

  1^5. Structure.

   1^6. Microscopical.

   2^6. Chemical.

   3^6. Mechanical.

  2^5. Divisions.

   1^6. Head and Neck.

    1^7. Name most important Muscles.

 3^4. Digestive.

  1^5. Organs.

   1^6. Alimentary Canal.

    1^7. Divisions, etc.

   2^6. Glands.

 4^4. Circulatory.

1^5. Organs.   (Outline Organs.)

5^4. Respiratory.   (Outline Organs.)

6^4. Secretory.   (Outline Organs.)

7^4. Nervous.   (Outline.)

8^4. Special Sense.   (Outline.)

ARITHMETIC.

All teaching should have for its object the development of correct modes of reasoning aad expression. It is not sufficient that pupils have *some* idea of the branches studied or subjects discussed, but they should have in their minds a *clear* idea which they are able to express with ease and cogency to others. This power is of inestimable value. The principles of correct reasoning are universal, and can be learned as readily in Arithmetic as in any of the higher branches of Mathematics. When once learned, they are learned forever, and the progress of the pupil ever after becomes a matter of ease and pleasure.

The principles may be exhibited under the following:

1. POINTS.

I. 1. Penmanship; 2. Spelling; 3. Capitalization; 4. Punctuation; 5. Neatness of figure; 6. Form; 7. General business-like appearance. All these points should be looked after with great care, at every recitation.

II. PROCESSES. 1. *Leading Steps.* (1) The statement of the problem; (2) The solution proper; (3) The conclusion. 2. *Subordinate Steps.* (1) Numbering equations; (2) Using proper signs; (3) Preliminary remarks; (4) Logical arrangement of equations.

2. MODEL SOLUTIONS.

As an illustration of the foregoing remarks we present a few solutions designed to indicate correct principles of reasoning as learned from Arithmetic.

MISCELLANEOUS PROBLEMS.

I. A man bought at one time, 200 acres of land; at another, 300; at another, 250; at another, 420; subsequently he sold, at one time 400 acres, and at another, 150; how much had he remaining?

II.
1. $200 + 300 + 250 + 420 = 1170 =$ the amount of land purchased.
2. $400 + 150 = 550 =$ the amount sold.
3. $1170 - 550 = 620 =$ the number of acres remaining.

III. ∴ The man had 620 acres remaining.

I. What will 7 cords of wood cost at $6 a cord?

II.
1. 1 cord $= \$6$.
2. 7 cords $= 7 \times \$6 = \$42$.

III. ∴ 7 cords of wood will cost $42 at $6 a cord.

I. A merchant sold in one year 1800 yards of calico at 20 cts. a yard; 125 yards of muslin at 12 cts. a yard, and 1200 yards of tape at $16\frac{2}{3}$ cts. a yard; how much did it all amount to?

II.
1. 1800 yds. of calico @ 20 cts. $= \$360.00$
2. 125 yds. of muslin @ 12 cts. $= $ 15.00
3. 1200 yds. of tape @ $16\frac{2}{3}$ cts. $= $ 200.00
—————
$575.00

III. ∴ Total receipts are $575.00.

I. If 1 yd. of cloth cost $2, what will 20 yds. cost?

II.
1. The cost of 1 yd. $= \$2$.
2. The cost of 20 yds. $= 20 \times \$2 = \$40$.

III. ∴ If 1 yd of cloth cost $2, 20 yds. will cost $40.

In analysis, the sign $\times$ is always read "times," and never "multiplied by."

Explanation.—The cost of 20 yds. of cloth $= 20$ times $\$2 = \$40$. This makes the $2 the multiplicand; the 20, when repeated, an abstract number—the multiplier; and the product is of the same kind as the multiplicand.

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In the above problem the reasoning is from one to many. In the following the reasoning is from many to one:

I. The cost of 20 yds. of cloth is $100, what is the cost of 1 yd ?

II. $\begin{cases} \text{1. The cost of 20 yds. of cloth} = \$100. \\ \text{2. The cost of 1 yd. of cloth} = \frac{1}{20} \text{ of } \$100 = \$5. \end{cases}$

III. ∴. If 20 yds. of cloth cost $100, 1 yd. will cost $5.

Problem:

I. Reduce 2 yds., 2 ft., 7 in. to inches.

(a) *Descending.*

II. $\begin{cases} \text{1. In 1 yd. there are 3 ft.} \\ \text{2. In 2 yds. there are 2 times 3 ft., which are 6 ft.} \\ \text{3. 6 ft.} + \text{2 ft.} = \text{8 ft.} \\ \text{4. In 1 ft. there are 12 inches.} \\ \text{5. In 8 ft. there are 8 times 12 in., which are 96 in.} \\ \text{6. 96 in.} + \text{7 in.} = \text{103 in.} \end{cases}$

III. Therefore, in 2 yds., 2 ft., 7 in., there are 103 inches.

(b) *Ascending.*

Problem:

I. Reduce 25591 gr. to ℔ Troy.

II. $\begin{cases} \text{1. 24 gr.} = \text{1 pwt.} \\ \text{2. In 25591 gr. there are as many pwt. as 24 gr. are con-} \\ \quad \text{tained times in 25591 gr., which are 1066 times with} \\ \quad \text{7 gr. remaining.} \\ \text{3. 20 pwt.} = \text{1 oz.} \\ \text{4. In 1066 pwt. there are as many oz. as 20 pwt. are con-} \\ \quad \text{tained times in 1066 pwt., which are 53 times with 6} \\ \quad \text{pwt. remaining.} \\ \text{5. 12 oz.} = \text{1 ℔.} \\ \text{6. In 53 oz. there are as many ℔ as 12 oz. are contained} \\ \quad \text{times in 53 oz. which are 4 times with 5 oz. re-} \\ \quad \text{maining.} \end{cases}$

III. Therefore, in 25591 gr. there are 4 ℔ 5 oz. 6 pwt. 7 gr. Troy.

COMMON FRACTIONS.

I. $8\frac{1}{2} + 6\frac{2}{3} = ?$

II. $\begin{cases} \text{1. } 6 = \text{L. C. M. of denominators.} \\ \text{2. } \frac{1}{2} = \frac{3}{6}. \\ \text{3. } \frac{2}{3} = \frac{4}{6}. \\ \text{4. } \frac{3}{6} + \frac{4}{6} = \frac{7}{6} = 1\frac{1}{6}. \\ \text{5. } 8 + 6 = 14. \\ \text{6. } 14 + 1\frac{1}{6} = 15\frac{1}{6}. \end{cases}$

III. ∴. $8\frac{1}{2} + 6\frac{2}{3} = 15\frac{1}{6}.$

PROPORTION.

I. If 15 men mow 11 A. in 5 days, how many men will mow
    33 A. in 9 days?

II. $\begin{cases} 1. & \text{15 men} \underline{\quad} \text{11 A.} \underline{\quad} \text{5 days.} \\ 2. & \text{— men?} \underline{\quad} \text{33 A.} \underline{\quad} \text{9 days.} \\ 3. & \text{15 men} = 5 \times 33. \\ & \underline{\qquad\qquad} \text{(cancelling)} = 25 \text{ men.} \\ & \quad 11 \times 9. \end{cases}$

III. ∴ 25 men can mow 33 A. in 9 days.

PROBLEMS IN PERCENTAGE.

100 % is the unit.

I. Required, 10 % of $200.

II. $\begin{cases} 1. & 100\ \% = \$200. \\ 2. & 1\ \% = \frac{1}{100} \text{ of } \$200 = \$2. \\ 3. & 10\ \% = 10 \times \$2 = \$20. \end{cases}$

III. ∴ 10 % of $200 is $20.

I. $50 are how many % of $500?

II. $\begin{cases} 1. & \$500 = 100\ \%. \\ 2. & \$1 = \frac{1}{500} \text{ of } 100\ \% = \frac{1}{5}\ \%. \\ 3. & \$50 = 50 \times \frac{1}{5}\ \% = \frac{50}{5}\ \% \text{ or } 10\ \%. \end{cases}$

III. ∴ $50 are 10 % of $500.

I. $500 are 20 % of how many dollars?

II. $\begin{cases} 1. & 100\ \% = \text{required number of dollars.} \\ 2. & 20\ \% = \$500. \\ 3. & 1\ \% = \frac{1}{20} \text{ of } \$500 = \$25. \\ 4. & 100\ \% = 100 \times \$25 = \$2,500. \end{cases}$

III. ∴ $500 are 20 % of $2,500.

I. $400 are 20 % less than what?

II. $\begin{cases} 1. & 100\ \% = \text{the number.} \\ 2. & 100\ \% - 20\ \% = 80\ \%. \\ 3. & 80\ \% = \$400. \\ 4. & 1\ \% = \frac{1}{80} \text{ of } \$400 = \$5. \\ 5. & 100\ \% = 100 \times \$5 = \$500. \end{cases}$

III. ∴ $400 are 20 % less than $500.

I. $600 are 20 % more than what?

II. $\begin{cases} 1. & 100\ \% = \text{the number.} \\ 2. & 100\ \% + 20\ \% = 120\ \%. \\ 3. & 120\ \% = \$600. \\ 4. & 1\ \% = \frac{1}{120} \text{ of } \$600 = \$5. \\ 5. & 100\ \% = 100 \times \$5 = \$500. \end{cases}$

III. ∴ $600 are 20 % more than $500.

The solutions of these problems explain all the cases
in Percentage.   The problems taken are easy, yet the
same analysis will answer, no matter how complex the
statement.   If the pupil thoroughly understands these
solutions he will be able to solve any problem in Per-
centage or any of its applications.

THOUGHTS AND SUGGESTIONS ON EDUCATION.

BY PROF. W. H. VENABLE.

1. It is not easy to learn to think; nor is it easy to think after learning how. The big-brained Carlyle says: "True effort, in fact, as of a captive struggling to free himself: that is Thought!" We are bound down by many cords of usage and ropes of authority; and it takes force and courage to break the bonds— to think in regard to Education.

2. Many regard the speculative philosophy of Education as mere fog and delusion. There is much fog and delusion brooding over the subject; but the solid land of True Science must be somewhere beyond the mist.

3. Before we can safely run the train of Right Method along the track of Practice, the headlight of Theory must shine into the opening way.

4. Doctor Harris, the Great American Philosopher of Education, has benefited the system more by his lectures and writings than any twelve mere unthinking, practical superintendents.

5. The teacher can not teach anything; the pupil *must learn.* You can no more think for your pupil than you can digest food for him. The mind is soli-

tary in its real achievements.   We must work out our
intellectual salvation, alone.   Teachers can order the
"environment" but not do the vital work of another
spirit.

6. Not the studies, but the study, makes the scholar.

7. Education is the Science of Life, and conduct is
its cognate art.

8. I do not believe in fitting boys for college, if
that fitting unfits them for life.   The one fitting should
be the other.

9. You are all your ancestors, including the Old
Adam.   Judge your pupil in the light of his heredity.

10. The perfect work of Education can not be ac-
complished except in the individual who comes of a
stock cultivated for generations.   Training your pu-
pil, you may be training his great grandson.   Infinite
are the reaches of the schoolmaster.

11. Stupidity, stolidity, inaptitude for special stu-
dies, vicious tendencies, are to be regarded as chronic
disease—the pupil may slowly be cured.

12. Many teachers of morality destroy the good
effect of judicious counsel by too much talk, as a chem-
ical precipitate is redissolved in an excess of the pre-
cipitating agent.

13. The best teacher has in view not his own edu-
cation, but that of his pupils.   They are his study;
not the subject he teaches.

14. Take care of the blockheads and the heads will
take care of themselves.

15. All schooling in school should be supplemented
and tested by schooling out of school.

16. The school must recognize its constant vital

connection with the world around.   Every teacher's desk should be in sight of the great facts of the time in which we live.   Boys are men, girls are women, *to-morrow.*

17.   Like the ancients, we must teach virtue as well as smartness.   No good education can be based on mere intellectuality.

18.   Bain is wrong in assuming that affection can play but a small part in teaching.   Human love and sympathy play the greatest part in early training. They play the greatest part even in a class in mental arithmetic.

19.   We should have a "Science of Education" written by a Platonist.   The best works we now have are based on the Materialistic Philosophy.   Let us see both sides.

20.   We neglect political education in our schools. Every boy and girl should be taught the elements of politics and economics; and especially, in these times, should the young be inspired with a pure patriotism and a religious devotion to the duties of citizenship.

21.   Educational theory and practice should proceed from the faith that there is a God at the center of the Universe, and a soul at the center of Man.

COURSE OF STUDY FOR THE DISTRICT SCHOOL.

PROF. J. M. LONG.

In making out a course of study for the district school, as well as for all other grade of schools, there are certain fundamental principles which should be observed. The first is that in every grade of school, the lowest as well as the highest, the course of study should present a complete picture or image of the world as the mind of Humanity has, through the ages, reflected this in the forms of thought, Science, or knowledge, viewed as an organic whole, is a reflection or image in thought of the external world or universe. Now, each grade of school in the matter of its mental work and development, should be a complete image of this reflected thought of Humanity. This is necessary in order that the education of the individual shall be a miniature repetition of the education of Humanity. In a harmonious and symmetrical education in the spirit of Humanity by a kind of metempsychosis, lives again in the individual.

A second fundamental principle is that the mind is so constituted that in order to the thorough mastery of any branch of knowledge, it must recur again and again to the same subject. No one branch can be

learned once for all in its completeness and finer de-
tails. It must be recurred to again and again, but
each time in a more thorough and systematic manner.
Hence, each essential element which goes to make up
a complete picture of knowledge, should in some phase
of itself find a place in every grade of school. The
district school should of course present all these ele-
ments, yet in their simplest and lowest form, thus ad-
mitting of a continuous advance from the more simple
to the more complex phase of each subject.

We would, in the next place, consider briefly the
form which knowledge has assumed through the grad-
ual evolutions of human thought. We find that hu-
man thought has unfolded into a three-fold order of
development. When we study the material *Cosmos*,
with its phenomena, properties, laws and forces, we
have one comprehensive branch of knowledge, which
has been termed *Cosmology*. When we study Human-
ity as this appears as a manifestation of mind, super-
imposed upon the cosmical movement, with its intel-
lectual, social, spiritual, and moral forces, we have
what may be termed *Andrology*, or the Science of Man.
The work of progressive development in the finite
sphere of being is carried on by means of the lower
unconscious forces of Nature becoming linked on
to the higher conscious forces of Humanity. But
thought can not find repose in the knowledge of finite
phenomena—with the material, visible panorama of
things. It finds repose only in the all-embracing
Unity which is, at once, the explanation and harmony
of the Universe. Thought finds its goal in Absolute
Being, which constitutes the God of Nature and of

Revelation. This phase of thought leading the mind up to the study of Being has been termed *Ontology*, the science of being in its *essential* and *absolute* nature in contradistinction to being in its accidental and relative phases. Thus the mind in reflecting a complete image of the universe rises to the conception of a *Cosmos*—a beautiful and divinely arranged world of law and order, hung in space and journeying through time, in the midst of which lives and moves a conscious Humanity, while over all rules one supreme Intelligence as the central fountain of all law and energy.

In those three grand divisions of knowledge— Cosmology, Andrology, and Ontology—thought has developed into an increasing clearness certain scientific ideas called categories, meaning by these the most simple and fundamental ideas or classes within which the objects of knowledge can be embraced and arranged in a system. In Cosmology we have the categories of *quantity, force and motion,* and *organism;* in Andrology we have the category of Mind as manifested in its reactions on mind, and also an external material nature ; in Ontology we have the category of Being which furnishes the common basis on which rests the generalizations of all science. *Absolute Being* is the category of categories, and the last which the mind reaches by analysis and abstraction. Each of these categories has become the germ out of which has sprung the specialized branches of Science.

Quantity has unfolded into Mathematics, motion and force into Dynamics, organism into Biology or Organics, mind in its reactions on mind into Sociology

or Historics, and as manifested in its reactions on external material nature in the form of *will*, it unfolds into what may be termed *Pragmatology*, from the Greek *pragma*, meaning a thing done. This department is properly so termed because it covers all the actions of mind as *will* which assumes a dynamic relation to material nature, changing its plastic elements into forms of *use* and *beauty*. This covers the domain of Art. The category of Being unfolds into Philosophy and Theology, according to the point of view from which this is apprehended.

Guided by these categories of knowledge, we are enabled to tabulate a philosophic course of study for any grade of school. In the district school, as already indicated, these categories should unfold into their respective sciences only in their simple and elementary form. In the higher grades, culminating in the college or university, there will be a gradual unfoldment into an increasing complexity, thoroughness, and fullness. A course of study for the district school, based on the foregoing principles, may be presented in tabular form.

It will be seen in the following table that we have assigned less mathematics in order to make room for natural science studies in harmony with the demands of the age. Geography is embraced within the category of Organism for the reason that the earth, in contrast to the moon, is a living planet, and hence has its functions:

	I. COSMOLOGY.			II. ANDROLOGY.		III. ONTOLOGY.
	1. The inorganic sciences dealing with the laws and properties of			2. The organic sciences dealing with the laws and properties of *mind* — 1. The sciences pertaining to Man in his social relations, and arising from the reactions of *mind*	2. The Arts, useful and aesthetic, arising from the reactions of *mind* on external *Nature*.	1. Theology, bas'd on the category of Absolute Being conceived as the Infinite Person. — 2. Philosophy, based on the category of Absolute Being viewed as the ultimate principle in the generalizations of Science.
	Quantities.	Motions & Forces	Organisms.	Sociology, or Histories.	Pragmatology, or Technics and Linguistics.	Natural theology
	Mathematics	Dynamics.	Organics.			
Class of School. District School.	Arithmetic. El. Algebra.	The elements of molar and molecular Physics.	Geography. Elementary lessons in Botany. Physiology. Hygiene. Zoology.	History of United States.	Spelling. Reading. Writing. Grammar. Drawing. Music (vocal).	Divine Wisdom, " Goodness, " Design, " Power, (to be taught in connection with natural science lessons.)

TEACHING NATURAL PHILOSOPHY.

G. DALLAS LIND, M. D.

[This article was taken from an old number of *The Normal Teacher*.]

The following outline prepared by J. L. Myers was selected from a number presented by my class at the close of a six weeks course in Natural Philosophy. I have made no changes except the omission of details. This I was obliged to do in order to bring it within the scope of an article for *The Normal Teacher*.

To those who maintain that nothing can be done in so short a time as six weeks in Philosophy, I have only to say that the members of this class, although they may not have all the definitions in the books at their tongues' end nor be able to explain or describe all the minute points of the subject, I am confident that they have a clear conception of the leading and fundamental principles of the science and have learned how to use a book in the investigation of the subject, or to sum up, they have laid a good, solid foundation and can now without the assistance of a teacher pursue the subject to any desirable extent.

It is not claimed that the outline is above criticism. I preferred to give it without change as better representing the work of the pupils.

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I will state further, that this class prepared the apparatus and performed above forty experiments illustrating the more important points:

EXISTENCE:

1^1. Force, that which causes changes in the form or condition of matter.

1^2. Kinds.

1^3. Massic, taken as a mass.

1^4. Gravitation, the tendency of all matter in the universe toward all other matter.

1^5. Terrestrial, applied to the action of the earth's mass upon terrestrial bodies.

1^6. Laws.

1^7. The space described by a falling body in any given second, is equal to the product of the number of seconds into twice the space described the first second.

2^7. The velocity acquired by a falling body at the end of any given second is equal to the product of the number of seconds into twice the space described the first second.

3^7. The total space described by a falling body at the end of any given second is equal to the product of the square of the number of seconds into the space described the first second.

2^6. Results.

1^7. Weight, the measure of the force by which any given portion of matter gravitates to the center.

1^8. Specific.

1^9. Obtained by multiplying the specific gravity by the weight of the unit of water or air.

2^9. Unit of comparison.

1^{10}. Air, for gases and vapors.

2^{10}. Water, for solids and liquids.

2^8. Absolute, the force which the earth's attraction exerts upon it and is expended in pressure against its support.

2^7. Equilibrium, a state in which two or more forces balance each other.

    1^8. Stable, when a body will return to its original position after it has been displaced.

    2^8. Unstable, when a body tends to depart farther from its original position after it has been displaced.

    3^8. Neutral, when it remains at rest in any position after it has been displaced.

3^7. Centrifugal force tends to make bodies fly farther from their center.

4^7. Centripetal force tends to draw bodies toward the center.

2^5. Universal, the attraction between distant bodies.

  1^6. Laws.

    1^7. The times of vibration of any two pendulums are proportional to the square roots of their length.

    2^7. The lengths of any two pendulums are proportional to the squares of their times of vibration.

    3^7. The intensities of gravity at any two places are inversely proportional to the squares of the times of vibration of the same pendulum.

    4^7. The length of any two pendulums vibrating in the same time are directly proportional to their increments of gravity.

2^4. Muscular, that which is produced by the strength of the muscles acting directly through machinery.

  1^5. Elements of machinery.

    1^6. Lever.

    2^6. Wheel and axle.

    3^6. Pulley.

    4^6. Inclined plane.

    5^6. Wedge.

    6^6. Screw.

2^3. Molecular.

  1^4. Cohesion is the force which causes like molecules to unite in one mass.

    1^5. Estimated by the resistance which its particles offer to a strain tending to rend them.

    2^5. Applied.

        1^6. By a direct thrust.

        2^6. By a pull.

        3^6. By a bending.

        4^6. By a twisting.

     2^4. Adhesion, the force which causes the molecules of the different kinds of matter to cling together.

       1^5. Facts relating to the force of adhesion.

         1^6. That it exists only between unlike molecules.

         2^6. That it varies with the kind and state of matter.

       2^5. Varieties.

         1^6. Solids to solids.

         2^6. Solids to liquids.

         3^6. Liquids to solids.

         4^6. Solids to gases.

         5^6. Gases to solids.

         6^6. Liquids to liquids.

         7^6. Liquids to gases.

         8^6. Gases to liquids.

         9^6. Gases to gases.

    3^4. Light.

    4^4. Heat.

    5^4. Electricity.

    6^4. Magnetism.

2^1. Matter.

  1^2. Properties.

    1^3. Universal.

      1^4. Extension.

      2^4. Divisibility.

      3^4. Indestructibility.

      4^4. Inertia.

      5^4. Impenetrability.

      6^4. Porosity.

      7^4. Compressibility.

      8^4. Expansibility.

      9^4. Mobility.

      10^4. Weight.

      11^4. Elasticity.

    1^3. Specific.

      1^4. Elasticity.

2^4. Tenacity.
3^4. Hardness.
4^4. Brittleness.
5^4. Ductility.
6^4. Malleability.
2^2. States.
  2^3. Solid.
  3^3. Liquid.
  4^3. Gaseous.

CHEAP APPARATUS.

G. DALLAS LIND, M. D.

[Taken from an old number of *The Normal Teacher*.]

The time was when books were so scarce and consequently so dear that only the richest men could afford to own one. The Bible was kept chained in the churches just as a drinking cup is now sometimes kept chained to a pump or fountain in public places. Note the progress from that day to this. Now, the great works of the great authors can be had for a few cents. Books that formerly cost many dollars can now be had for the price of a few hours labor, and yet authors and publishers make money. The secret of it all is that there is a great demand for books and reading matter generally. The demand has stimulated men to devise ways of supplying it. New inventions have of this necessity arisen and the supply can keep pace with the demand. The large sales compensate for small profits.

Many of us can remember when a wall map or globe or, in fact, any kind of apparatus, except a birch rod, was as rare in a district school-house as log school-houses are to-day in the older parts of our country. We are sorry to say that many school-houses to-day have yet little or no apparatus, but great advances have been made in the last ten or fifteen years.

It is well known that great pains and labor were be-

stowed on the first books that were made. Days were spent by those who copied books in ornamenting and embellishing the initial letters of chapters. This work added to their cost. Many of the books printed in an early day were also elegantly bound and ornamented, and, in fact, it is only within a quite recent period that books have been made in a cheap style to any great extent. Now the complete works of Shakespeare can be had for twenty-five cents, and nearly all of the master-pieces of the writers of present and past ages can be had for ten cents each. No one is excusable for not possessing at least some standard works.

The work of cheapening apparatus has begun also. The apparatus furnished for many of our high schools and colleges costs a small fortune, it is true, but many teachers are learning to make their own apparatus and the demand for means of illustrating science has so increased that manufacturing firms are now putting up many pieces of apparatus at a comparatively low price. For example, globes can now be had for ten cents, not very durable nor very large, but yet answering all the purposes of a globe which can be used to illustrate the important principles in Geography. Globes which will serve the purpose can be obtained even cheaper than this, as one firm at least is now making paper collar boxes in the form of globes so that you can get a globe and ten collars for twenty-five cents.

Take away the paint and varnish and ornaments and some of the simply convenient arrangements of apparatus and there will be but little left which can not be made by the teacher or student at a very small expenditure of time and money.

The teacher's ability may be measured by his power of illustrating principles by means of apparatus. So far as possible he should make his pupils use the apparatus, and if possible make them construct the apparatus. In some of our progressive normal schools the plan of encouraging pupils to construct their own apparatus now prevails.

Some of these schools now have a special department for this purpose, a manufacturing laboratory, where, under a competent instructor, pupils can manufacture, not only the more simple forms of apparatus, but such apparatus as magnets, electrical machines, air pumps, compound and solar microscopes, telescopes and spectroscopes. Of course it is necessary to buy lenses and glass plates or mirrors which form parts of some of these pieces of apparatus, but they are put together and the greater part constructed entirely in the laboratory and the work is done by the students themselves. Thus for a few dollars, pieces of apparatus can be constructed which if bought would cost many times as much. The additional point is gained, that when a teacher who constructs such apparatus, knowing how it is made, can repair it when it gets out of order. There are many teachers who own air pumps but can not use them simply because having become out of order they did not know how to repair them. It should be a part of their education to learn how such machines are constructed as well as to know how to use them.

It has been said that a man who can not bore a hole with a saw or saw off a board with an augur should not study Chemistry. This is placing it in rather a strong light, but there is much truth in it. The teacher

of any branch needs this ingenuity, or, in other words, the power of adapting himself to circumstances. If a teacher can not prevail on school boards to provide appropriate apparatus he should be ingenious enough to construct something that will answer the ends.

Why should so much money be expended for apparatus elegantly finished and which only a few are able to purchase, when the same money might be spent in multiplying the same apparatus and thus bringing it within the reach of all.

Not only should teachers who expect to teach the Natural Sciences regularly in their schools be provided with means of illustration but all teachers need in connection with a knowledge of these branches means of illustrating them that they may be able to interest and instruct children in some of the more important general principles of these sciences. Such exercises are of vast importance in securing punctual attendance at school and in waking up minds otherwise dormant. We can not estimate the influence which such instruction will have on the future generation. The writer has a natural love for the branches of Natural Science and he can trace the origin of it to the fact that in his early youth certain books were thrown in his way, which attempted to simplify and illustrate the great principles of science. He also can trace a certain part to casual instruction given by some of his early teachers. We may without hesitation predict that the next generation will possess a much greater love for those sciences which treat of the common things around us and which lie at the foundation of our earthly wants and consequently the main causes of our earthly happiness.

THE IMPORTANCE OF SCIENCE IN OUR PUBLIC SCHOOLS.

J. E. BAKER, M. D.

I wish to say a few words on the subject of electricity, by means of which so many practical and beautiful experiments can be performed and so much interest and wonder elicited from both older and younger pupils.

For twenty-five cents a person can be provided with a horse-shoe magnet. Magnetize two darning-needles by drawing them from end to end along one of the ends of the magnet. Then suspend one of the needles with a silk thread; take the other in your hand and bring the eye-end of it near the eye-end of the suspended needle and it retreats. Bring the points near each other and one suspended retreats also. Now bring the dissimilar ends near each other and they attract each other. In the first instance we have repulsion, and in the second attraction. The experiment can be varied by balancing one of the needles on your thumb nail, then proceeding as before. Much can be said by the teacher or pupil with the magnet and this impressive experiment, concerning magnetic poles, magnetic attraction and repulsion, magnetization, induction, kinds of magnets, etc., etc.

You can illustrate Statical or Frictional electricity with a great variety of experiments. A glass tube rubbed with a silk handkerchief, or a stick or rod of sealing wax rubbed with flannel, or a gutta-percha comb passed through the hair briskly—each of these when rubbed or excited as stated will attract bits of paper, a suspended pith ball, or a yard stick suspended by a silk thread. The suspended pith ball will be immediately repelled after it is attracted, showing the attractive and repellent nature of Frictional electricity. A multitude of interesting facts and beautiful ideas can be shown by these experiments. A notion seems to prevail that in order to perform experiments in electricity very expensive apparatus is needed, but the ingenious teacher or the pupils under his guidance can construct almost all of the necessary apparatus. A teacher who is a success in the school-room certainly has enough contrivance to make some apparatus to illustrate a few common-sense principles of every day life.

By referring to some work upon Natural Philosophy any teacher can make, with a few cents, a simple galvanic battery illustrating Dynamical or Chemical Electricity. With this single cell battery a spark can be obtained, a magnetized needle deflected, induction shown, etc., etc.

It appears that there can be no question as to the utility of the study of the Natural Sciences, at least elementary Philosophy and Chemistry. The objections in a great measure are from those ignorant of the sciences; especially their practical application. It is certainly patent to every mind upon the slightest re-

flection that a practical knowledge of the common phenomena that stare us in the face every day is just as necessary to make useful and practical business men as to know the dry technicalities of Grammar as usually taught.   Which is the most important to have, a practical knowledge of the common pump, or to know why we use 300 in extracting the cube root?   Which is explained the most frequently?   Is there no advantage in knowing something about latent heat, the steam engine, lightning-rods, and the telegraph?   The gas of coal mines, and the gas forming what is termed damps in wells, which is so destructive to human life, can, with a few cents, be made even by pupils, and their properties noted.   Don't these facts come under the domain and practical operations of human existence?   The study of these subjects affords excellent opportunities for discipline and culture.   I don't undervalue the study of mathematics in the least because I have witnessed the beautiful effects of mental discipline from rigid mathematical drill.   But I do claim that a knowledge of those practical facts over which we stumble every day is *just* as necessary to the attainment of business power.

Scientific experiments constitute one of the best means of exciting an interest and arousing a curiosity among pupils either by a regular class or an occasional experiment.   They also afford advantages of securing culture and refinement besides the illustrations of scientific principles.   Throw the responsibility of making apparatus and the explanation of experiments upon the pupils and they will be as busy as bees in hunting up materials for apparatus and in investigating the

text-books for facts.   Their minds will be so wholly taken up, so absorbed with the beautiful and brilliant experiments and their own explanations that they will not have the least possible time to loiter around in idleness and listen to the street-corner vulgarity and profanity.   It seems evident beyond all cavil that if the minds of children could be diverted in a pure and healthful channel from the rough and unrefined vagabondism so prevalent everywhere, it ought to be done by all means, and would certainly be a great blessing to rising humanity.

ALGEBRA AND GEOMETRY.

BY PROF. R. H. HOLBROOK,

Vice-President of the National Normal University, Lebanon, Ohio, and editor of the *National Normal Exponent*.

So much *in*formation is given by our teaching and so little *ex*formation! It is perpetual ingoing, while outcoming is the exception. What a pupil knows is unimportant. What he can tell, of his knowledge, is essential. In many Algebra, as well as Arithmetic classes, the simple solution of the successive examples, as a mere process of imitation, is the outside limit of the instruction.

I look upon Algebra as pre-eminently a Rhetorical study. It is here that thought is put in exact phraseology. It is here that the argument upon a proposition is exactly stated, vigorously evolved, and undisputably conducted. It is here that language is precise, logic is clearly defined, and the processes of thought are practically "materialized." And although so many examples may not be solved, it is of the first importance that the teacher give his pupils power to think thinking, to discover in themselves a new consciousness of mental processes. He should train them to expose to their own view and to his inspection written evidence of the workings of their own minds.

It was a grand conclusion Des Cartes reached: "I think, therefore I am." It was the foundation of faith. Slightly modified it becomes the very foundation of all certain knowledge: "I know how I think, therefore I think right."

This will be partially secured by having the pupils write out their examples in a strictly logical form. The following outline will be found useful for this purpose:

Outline of Solution of Example.

1^1. Statement = Conditions.
   1^2. Granted. 2^2. Required.
2^1. Operation.
   1^2. Synthesis = Forming the equation.
   2^2. Analysis = Solving the equation.
   3^2. Proof = Verifying the equation.
3^1. Conclusion.
   1^2. Granted. 2^2. Obtained.

I will present for illustration the following outline of the solution of Ex. 7, p. 95, Schuyler's Algebra:

1^1. Statement = Conditions.
   1^2. Granted.
     1^3. (1) A left town at the rate of 4 miles an hour.
     2^3. (2) B left 12 hours later at 10 miles an hour.
   2^2. Required.
     1^3. (3) Number of hours till B overtook A.
2^1. Operation.
   1^2. Synthesis = Forming the equation.

1^3.	(4) $x =$ hours B traveled.	by (2).
2^3.	(5) $x + 12 =$ hours A traveled.	by (1) and (2).
3^3.	(6) $10x =$ miles B traveled.	by (2).
4^3.	(7) $4(x + 12) =$ miles A traveled.	by (1).
5^3.	(8) $10x = 4(x + 12)$.	by (2) and (3).

   2^2. Analysis = Solving the equation.
     1^3. Clearing (8) of parenthesis, (9) $10x = 4x + 48$, by Post. 3.
     2^3. Transposing, (10) $10x - 4x = 48$, by Art. 129.
     3^3. Reducing, (11) $6x = 48$, by Art. 132.
     4^3. Div. by Co-eff., (12) $x = 8$, by Art. 135.

3^2. Proof = Verification of equation.
   1^3. Sub. in (9) = (13) 10.8 = 4.8 + 48.
   2^3. Reducing.   (14) 80 = 80, by Ax. 9.
3^1. Conclusion.
  1^2. Granted.
   1^3. A left town at 4 miles an hour.
   2^3. B left 12 hours later at 10 miles an hour.
  2^2. Obtained.
   1^3. The number of hours till B overtook A is 8.

Such forms are easily acquired, and, though at first they may apparently retard progress somewhat, it will be invariably found that, at the last, the advance will be much more speedy and the whole work more thoroughly done.

One or two examples of each lesson prepared in this way, should be brought in, sometimes on paper, usually on the slates at each lesson. The whole work can be quickly examined, graded, and records of the grade taken. These exercises may be " study," " recitation," " review," or " examination."

I submit it to the judgment of teachers, if preparing examples and exercises in such orderly form, would not serve to improve the slovenly, scrawling work that is more the rule than the exception in our schools?

What has been said of Algebra as a Rhetorical study is just as true of Geometry. Pupils, in beginning this subject, are frequently in great bewilderment, owing to their failure to appreciate the new technicalities and the logical limitations which the exact demands of the study place upon their reasoning. Although definitions, postulates and axioms may be faithfully recited, although the demonstrations of the theorems may be conscientiously parroted off,

yet, the beautiful, clean, clear-cut connections and re-
lations are utterly incomprehensible, and the pupil is
as likely to consider the demonstrandum the hypothe-
sis, and to know as little about where he is to conclude
as about where he is to begin.

I have found it to be a certain cure or prevention
of this to present to the class and have them copy the
following

Outline of the Demonstration of a Theorem.

1^1. Statement.
  1^2. General = The theorem.
    1^3. Hypothesis = Things granted.
    2^3. Demonstrandum = Things to be proved.
  2^2. Special = Diagram drawn and explained.
    1^3. Hypothesis = Lines, etc., granted.
    2^3. Demonstrandum = Things to be proved.
2^1. Proof.
  1^2. Construction = Explanation of lines added to aid in the
      proof.
  2^2. Argument.
    1^3. First Step = State and give authority.
    2^3. Second Step = State and give authority.
    3^3. Third Step = State and give authority, so on to
    4^3. Last Step, which should always be preceded by " There-
      fore," or its sign, and followed by the symbols
      " Q. E. D."
3^1. Conclusion.
  1^2. Special.
    1^3. Hypothesis. 2^3. Demonstrandum.
  1^2. General.
    1^3. Hypothesis. 2^3. Demonstrandum.

At the same recitation, and immediately following
this, I have them turn to a theorem, and by questions
enable them to direct me in placing upon the board a
complete outline of the theorem, just as I expect them

to do in preparing the lesson. A sufficient model of this will be found in the following:

Outline of Demonstration of Prop. IX, Loomis' Geometry, p. 24.

1¹. Statement.

    1². General.

        1³. Hypothesis:—If from a point within a triangle two straight lines are drawn to the extremities of either side;

        2³. Demonstrandum:—Their sum will be less than the sum of the other two sides of the triangle.

    2². Special.

        1³. Hypothesis:—Let two straight lines BD, CD be drawn from D, a point within the triangle ABC; (the drawing should always appear here.)

        2³. Demonstrandum:—Then will the sum of BD and DC be less than the sum of BA and AC, the other two sides of the triangle.

2¹. Proof.

    1². Construction:—Produce BD until it meets the side AC at E.

    2². Argument.

        1³. First Step, $CD < CE + ED$, by Prop. 8.

        2³. Second Step, $CD + BD < CE + EB$, by Ax. 4.

        3³. Third Step, $BE < BA + AE$, by Prop. 8.

        4³. Fourth Step, $BE + EC < BA + AC$, by Ax. 4.

    ∴ 5³. Last Step, $CD + BD < BA + AC$, by A.   Q. E. D.

3¹. Conclusion.

    1². Special.

        1³. Hypothesis:—Let two straight lines, BD, CD, be drawn from D, a point within the triangle ABC, to the extremities of the side BC;

        2³. Demonstrandum:—Then will the sum of BD and DC be less than the sum of BA, AC, the other two side of the triangle.

    2². General.

        1³. Hypothesis:—If, from a point within a triangle, two straight lines are drawn to the extremities of either side;

        2³. Demonstrandum:—Their sum will be less than the sum of the other two sides.

The preparation of a few such exercises seems to enable the particulars of a demonstration to adhere to the mind, as merely reading it over or committing it to memory does not. The rigid separation of the argument into steps with the faithful citation of authority, not by reference, as above, but by full quotation, clears away the fog thoroughly.

The teacher should usually reletter the diagram, but require the whole class to use the same lettering, so as to expedite the examinations of the papers.

The most thorough review of any given part will be accomplished by outlining it. Pupils will thus get the juice of Geometry in being led to discover that it is a beautiful evolution which needs only to be understood to be appreciated.

There are many other devices which the ingenious teacher will originate to give his pupils opportunity to subject their knowledge to the test of written expression. These exercises should make a splendid history of the progress of the class and the methods of the teacher.

NORMAL METHODS OF TEACHING THE HIGHER BRANCHES.

ANNIE M. SHERRILL.

We can not, in this connection, give detailed directions for teaching all the branches treated of in this book, but will attempt some hints and suggestions on several of the Sciences which we trust may lead toward basing your methods on rational, natural, true theories of teaching.

The field of Natural Science may be made most engaging to the young. What a new world and new order of things it opens to the view! But in many schools these subjects are presented in such a way that they fail to make any appeal. The dissertations and lectures on Science are very fine, probably, but fall short of enticing or interesting more than a few. We have in mind now a visit paid at no very remote day to one of the leading colleges of Indiana. A learned savant was discoursing on Science in his class. Himself and four or five members of the class seemed greatly interested—so much so as to have forgotten the thirty or forty around the room who were amusing themselves in various ways, very foreign to the subject. A class must be wrought up to the point of enthusiasm if any thing is to be accomplished. Some

of the expedients used by Normal teachers, for this purpose, and for the purpose of giving a practical understanding, and thorough grasp of subjects, are as follows :

1. Outlines made by pupils.

2. Investigations and reports made by pupils on special topics.

3. Experiments and lectures given by pupils before the class and invited visitors.

4. Geological cabinets collected by pupils.

5. Botanical collections made by pupils.

There is no way in which pupils can get a connected, comprehensive, and understanding view of a subject so well as by making a logical outline of it, in which everything is classified and arranged with reference to its relations to the different parts, and to the entire subject.   Let each recitation be such a discussion of any given theme or subject as will evolve an outline. Let the teacher, standing before the blackboard, chalk in hand, place upon the board, step by step, the outline thus drawn from the class in response to his hints and suggestions.   Pupils in a very little time "get the run" of outlining.   And just here let me say, lessons should be assigned by topics or subjects, and not by pages, and pupils should be encouraged and induced to look further in their investigation than the textbook in use.   Every teacher of higher branches should have some sort of reference library of his own, and before he will fail or come short of his ideal in teaching, he will place this in reach of his pupils—he will refer them to where they can find more information on

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the subject in hand. In this way they are encouraged to find out every thing they can on any given subject, and to arrange this information in the form of a logical outline. These outlines, being brought to the class, form the basis of the recitation. For instance, the branch being taught is Natural Philosophy, and the topic or subject assigned is Gravitation. Every one is expected to prepare an outline of this subject to the best of his ability, arranging all his points of information logically, numbering and writing all the points in place, with reference to their relation to the leading head, Gravitation, and to the still more general head, Force, as well as to the various subdivisions of the lesson. At the outset of the recitation one or two pupils are called upon to place their outlines of Gravitation on the board, while at the same time the teacher calls on some one to tell all he can about Gravitation, using his paper as a guide. He will probably not proceed far without falling into some error of omission or commission ; he fails to get at the bottom of a matter, or becomes somewhat mixed. Perhaps some hands will come up, otherwise the teacher will state that the speaker has, in a measure, failed, and call on some one else to take up the discussion. If the second fails to bring up what is lacking, he will call on a third, and in this way bring out from the class a corrected and correct outline, which the teacher places upon the board step by step as it is thus evolved, and the class at the same time remodel theirs upon the one the teacher places on the board. This class outline of Gravitation is then to be copied into the general outline which, at the close of the term, or two terms, which you may

devote to the subject, will form for each pupil an epitome of all that has been learned. The *subject* has been mastered, and not merely a heterogeneous mass of facts been committed to memory. Use various devices for giving each one something to do as often as possible. The plan of calling on some to place outlines on the board is an incentive to have material ready and in good shape for presentation, and these should be examined and criticised during recitation by the class, if there is time. Topics should also be assigned to members of the class for special investigation and report. The report may be either written or oral, but should always be brought up in the class, and comments or criticisms be called for from the class. Every recitation and exercise should be the occasion of drill in neatness, orderly arrangement, the use of correct language and correct spelling. Nothing prepared in a slovenly manner should be allowed to pass without notice, and the class, under the teacher's management, should be the critic. Thus they all get the benefit of the criticism.

And now let me dwell for a moment on the matter of allowing your class to do the reciting; thus they will be led to think, and the knowledge that they are expected to do something will lead to preparation. And always be sure that what they are expected to do is something they *can* do. This will never fail of arousing interest. But if you are one of the teachers who depend upon the questions in the book, and answer the most of them yourself, or depend on penalties to bring up answers, depend on it you are a failure as a teacher of Science or anything else.

The *third* point mentioned as one of the expedients used by Normal teachers for creating an interest in Science, is experiments and lectures given by pupils before the class and invited visitors. "In the majority of schools, perhaps, when experiments are performed to illustrate the subject matter, the work is done by the teacher, while the pupils look on and admire. Expensive apparatus is furnished and it is kept sacredly out of the way of the student, only to be touched by the professor. But the writer is happy to state that he knows of a few schools where the reverse is the case, and where the pupils perform the experiments and manufacture much of the apparatus at a trifling cost."—*From Preface of Easy Experiments in Chem. and Nat. Philosophy.*

It is the custom of our Normal teachers to devote one day of each week to these experiments in teaching Chemistry or Natural Philosophy. A week before the appointed day certain experiments are assigned to certain members of the class, and references given to book or books, giving description and directions for performing. The same experiments should be given to two or more at the same time, that they may assist each other in making apparatus, collecting materials, etc.; one, however, may act as chairman or spokesman of the committee in making all necessary explanations.

These explanations will consist of explaining the principle involved, and the manner in which the present experiment proves the principle to be true. Afterward the class is questioned on the experiment and explanations, to test their understanding of it, and to fix the whole matter in mind. A little practice in the

management of these experiments will give ease
and readiness, and a fondness for, and insight into,
the Sciences which no mere looker-on can acquire.
The teacher will find it necessary to give some per-
sonal oversight and directions, and as a very useful
hand-book in managing this department we recom-
mend our little book, *Easy Experiments in Chemistry
and Natural Philosophy*, price, 40 cents, containing a
great deal of useful information, hints and suggestions
on various scientific matters, besides complete directions
for performing 195 experiments in Chemistry and 104
in Natural Philosophy.

We now come to consider the forming of Geological
Cabinets and making Botanical Collections, upon which,
in connection with the outlining, the practical value
of these studies depends.   Let us first consider the
Geological Cabinets.   It seems a great reflection on
the teaching of Science that so very few of those who
have studied Geology in our schools, can tell the com-
position of a stone of their own neighborhood, or tell
what periods are indicated in the formations ex-
posed about them.   To practically acquaint pupils
with the geologic formations immediately about them,
in their own neighborhoods, is to give them a practi-
cal clue to much more.   Says Prof. R. H. Holbrook,
in his book, "The New Method," to which we refer
the teacher for more specific directions for teaching
these subjects, "The first and last consideration in the
Geology class is the minerals and fossils actually col-
lected by the pupils.   To manage this properly, time
must be taken; the book must be delayed; indeed,
portions of the book will have to be entirely omitted.

All this is a great bugbear to the quiet, orderly, easy-
going, dignified teacher, who scrupulously devotes the
stipulated six hours and no more, who, when he locks
the school-house door at night, locks school out of his
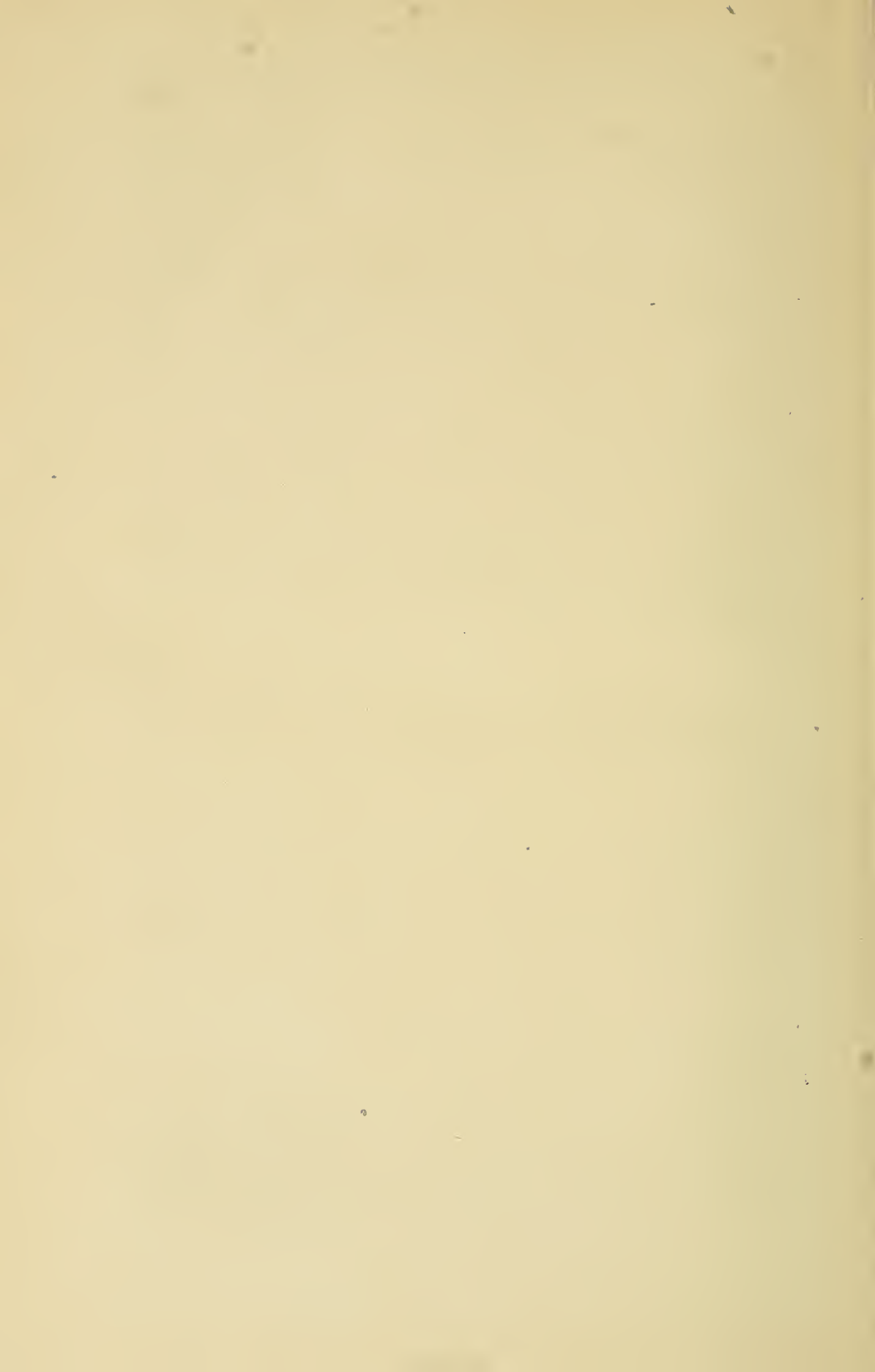mind until he opens up the next morning.

" To *teach* Geology the teacher must go into the fields
with his pupils; he must examine carefully quantities
of 'truck'; he must direct the labeling and mount-
ing of the specimens; he must examine and record
the work of each individual pupil, and give them suit-
able credit therefor; he must encourage the feeblest
attempts of lagging pupils."

Botany, where it is desired to teach it upon the
Normal plan, that of research and handling of the
plant on the part of the pupils themselves, should be
taken up in the autumn term of school, so that the
simpler and more perfect specimens of flowers can be
found, and so that the fields and lanes can be traversed
with immunity from the mud and dampness of our
early spring.

All Normal methods are based on the belief that
the best way to acquaint pupils with the facts, things,
and laws of arrangement, etc., of nature, is to allow
them to handle and see for themselves.   Do not teach
anything in the abstract, but teach every rule and
truth as applied to something in hand.

You can be a very good teacher of Botany if you
have a fondness for the study; if you have mastered
it sufficiently to make a good outline of it; if you have
enough experience to lead a class in the analysis of the
simpler flowers of your neighborhood; if you can
realize the importance of having each pupil record in

a book prepared for that purpose, the correct analysis of each flower analyzed by him, and of pressing, drying, and mounting on the herbarium sheets a good specimen of the plant and flower, and of recording on one leaf of the herbarium sheet, according to certain forms printed thereon, everything knowable about the plant.   In a short time pupils can trace flowers through to their common names, having been guided a few times in the use of the key by the teacher, and by recording their work for further reference, Botany becomes a real, an actual matter with them—a matter of value.   Herbarium sheets referred to above may be bought of J. E. Sherrill, Danville, Ind., and the plant record book may be obtained of Prof. R. H. Holbrook, Lebanon, Ohio.